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A Continuing Bibliography with Indexes

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March 1982

National Aeronautics and Space Administration

Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering Aeronautical Engineering

ACCESSION NUMBER RANGES

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NASA SP-7037(146)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 146)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in February 1982 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 442 reports, journal articles, and other documents originally announced in February 1982 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR,* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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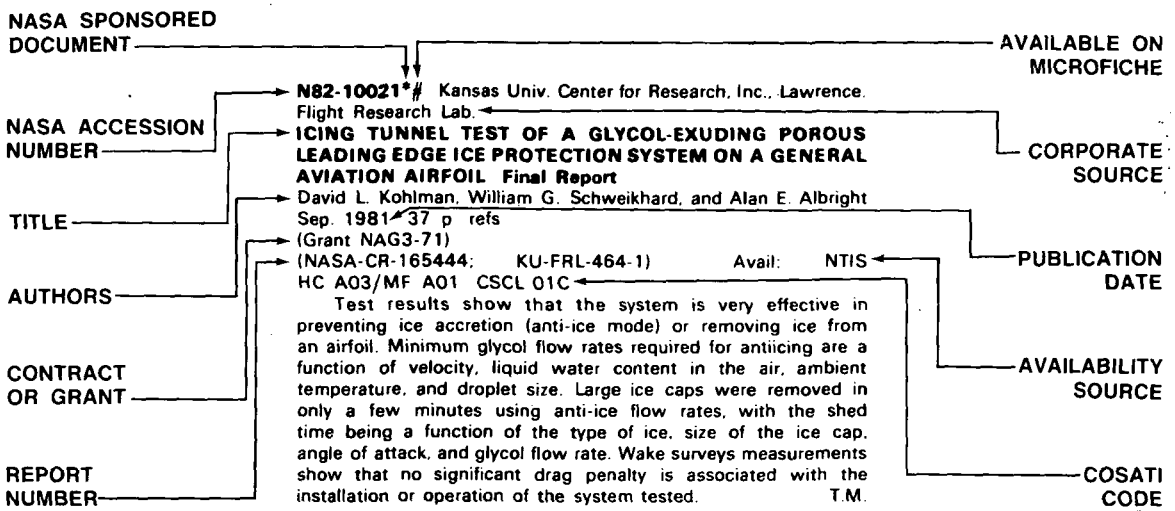

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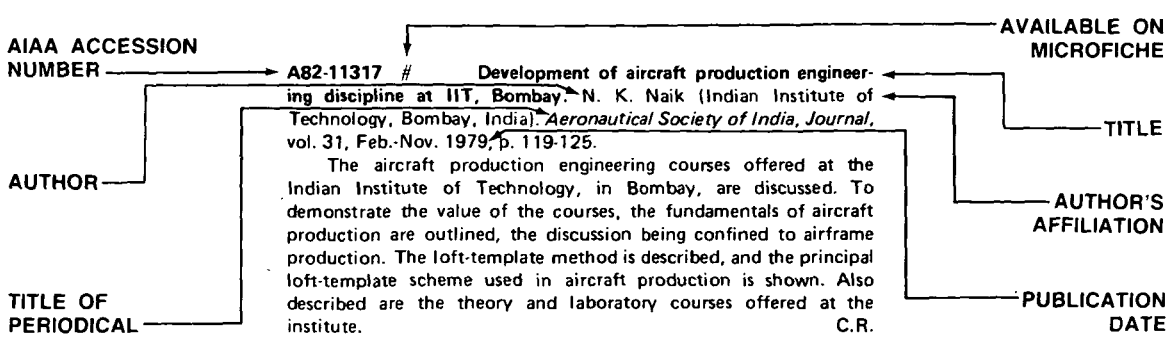

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 146)

MARCH 1982

IAA ENTRIES

A82-12987 **Creep and aero gas turbine design.** R. E. Jenkins (Rolls-Royce, Ltd., Aero Div., Bristol, England). In: International Conference on Engineering Aspects of Creep, Sheffield, England, September 15-19, 1980, Proceedings. Volume 1. London, Mechanical Engineering Publications, Ltd., 1980, p. 251-258.

Considerations given to creep in the design of aero gas turbines are reviewed. The basic requirements dictating the creep design of aero gas turbines are the attainment of the highest possible cycle temperature, consistent with the turbine cooling technology and the turbine life, and the maintenance of critical dimensions, such as clearance between rotating and static parts, throughout the service life. The importance of temperature assessment and definition and detailed analysis of typical flights is emphasized. V.L.

A82-13016 **ATARK laser tracking system.** R. Grimes and D. Baxter (Contraves Goerz Corp., Pittsburgh, PA). In: Electro-optics/Laser 80 Conference and Exposition, Boston, MA, November 19-21, 1980, Proceedings. Chicago, Industrial and Scientific Conference Management, Inc., 1980, p. 255-267.

The Automatic Tracking and Ranging Kit (ATARK) is a modular pulsed laser transceiver and electronics system suitable for a wide range of instrumentation requirements found in current programs at test ranges. The primary criterion has been to provide a system with the highest single data point accuracy. Key features of the tracker are modular construction, with processor/software control, operation at 1.06 micron, dual lamp cavity, variable pulse rate, coaxial TV system for visual record/viewing, and linear tracking error over the field of view. Using retroreflectors, the ATARK system is operational to ranges in excess of 100,000 feet and provides range data of one foot with measured tracking error of 100 microradians accuracy. P.T.H.

A82-13020 **Options for GTE precision automated tracking system.** D. Stark (GTE Sylvania, Inc., Mountain View, CA). In: Electro-optics/Laser 80 Conference and Exposition, Boston, MA, November 19-21, 1980, Proceedings. Chicago, Industrial and Scientific Conference Management, Inc., 1980, p. 302-306.

The overall design and performance of the basic PATS (Precision Automated Tracking System) and recently incorporated new features are discussed. The target tracking subsystem of PATS is a 100 pulses-per-second, 15 ns pulse-width laser transmitter and optical receiver mounted on an elevation-over-azimuth tracking mount. A quadrant photodetector is used in conjunction with an amplitude monopulse receiver to develop boresight error data. These data drive the servo system which keeps the laser pointed at the target. The absolute accuracy in azimuth and elevation is better than 0.1 milliradians, the maximum dynamics is 2.0 rad/sec, with an acceleration of 500 milliradians/sq sec. The new features include dual mode capability and automatic camera focus. V.L.

A82-13077 * ***Darboux points in minimum-fuel aircraft landing problems.*** E. Kreindler and F. Neuman (NASA, Ames Research Center, Moffett Field, CA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981, 5 p. (WA-1A). 13 refs.

An algorithm for suboptimal flight paths is used to show the existence of Darboux points on extremals of a fourth-order minimum-fuel horizontal aircraft landing problem; the states are two position coordinates, velocity and heading. It is shown that there is no simple relationship between Darboux points and conjugate points for a special second-order case of capturing a line at constant velocity. B.J.

A82-13078 **Fuel efficient flight profiles in an ATC flow management environment.** R. W. Schwab (Boeing Commercial Airplane Co., Seattle, WA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981, 6 p. (WA-1B).

The Flow Management research program was established to define the airborne navigation/guidance capabilities needed for efficient operation in the ATC Flow Management system under development; the Flow Management research is one element of the NASA Terminal Configured Vehicle program. This paper examines the Flow Management algorithms, and reviews in-plane geometry and ATC constraints, wind and temperature modeling, descent initialization, runway profile descent calculation, aeroperformance envelope determination, high profile descent calculation, and holding and path stretching. B.J.

A82-13079 * **A decoupled control system for improved flight performance in wind shear.** G. K. Miller, Jr. (NASA, Langley Research Center, Hampton, VA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981. 9 p. (WA-1D). 9 refs.

A fixed-base simulation study has been made to compare the approach and landing performance of a decoupled longitudinal control system and the velocity-vector control-wheel steering (VCWS) system that currently exists on the NASA Terminal Configured Vehicle (TCV). The decoupled control system employed constant prefilter and feedback gains to provide steady-state decoupling of flight-path angle, pitch angle, and forward velocity using symmetric spoilers, throttle, and elevator as active control elements. In severe wind shear, of the Kennedy-type, the decoupled control system improved both approach performance and touchdown performance even when the spoiler deflection was limited to 16 deg. On a 10-point rating scale, three research pilots rated the approach and landing task with decoupled controls as much as 3 to 4 increments better than the use of the VCWS system in severe winds. (Author)

A82-13088 **A dual input actuator for fluidic backup flight control.** M. F. Cycon, Jr. (Garrett Corp., Pneumatic Systems Div., Phoenix, AZ). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981. 8 p. (WA-8B). 5 refs.

This paper describes the application of pneumatic fluidics to obtain closed-loop position control of a high-pressure, direct-drive, electrohydraulic actuator. The fluidic control, which requires no electrical power, is a backup to the primary electronic control. Tests conducted using a prototype fluidic circuit demonstrate the feasibility of a dual input (electronic-fluidic) actuator using technologically dissimilar redundant control methods. (Author)

A82-13093 **Digital redesign of existing multiloop continuous control systems.** K. S. Rattan (Wright State University, Dayton, OH). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981. 8 p. (WP-1D). 9 refs. Contract No. F49620-79-C-0038.

A computer-aided method for converting existing multiloop continuous-data control systems into digital control systems is presented. Digital controllers are synthesized by matching the frequency responses of the digital control system to that of the continuous control system with a minimum weighted mean square error. Formulas for computing the parameters of the digital controllers are obtained as a result. An example of digitalizing existing continuous flight controller for the longitudinal YF-16 aircraft is considered and the results obtained are compared with those obtained by the Tustin transform. (Author)

A82-13094 **Digital control for flexible aircraft using reduced order models.** G. L. Slater and R. Kandadai (Cincinnati, University, Cincinnati, OH). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981, 6 p. (WP-1E). 9 refs.

A control synthesis is presented for a very flexible aircraft, and the effects on performance from different types of suboptimal approximations are compared. By examining the response at varying sample rates, it is shown that there is a tradeoff between model accuracy and computational feasibility. When the computational requirements of higher-order models are considered, the slow sample rates imposed by these requirements make the reduced order model a superior controller. B.J.

A82-13106 **Comparison between the exact and an approximate feedback solution for medium range interception problems.** J. Shinar (Technion - Israel Institute of Technology, Haifa, Israel), K. H. Well, E. Berger (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für dynamik der Flugsysteme, Oberpfaffenhofen, West Germany), and M. Negrin. In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981, 6 p. (TA-1A). 14 refs.

The forced singular perturbation technique (FSPT) is compared with a multiple shooting algorithm known for its high precision. Three-dimensional medium range air-to-air interception is formulated as a minimum-time control problem, and the formal optimal solution is outlined. The FSPT model of the original problem is introduced, and the zero-order composite feedback solution is presented. Results of the comparison for a characteristic example are discussed, and the comparison of the zero-order FSPT feedback approximation to the precise MSA solution was found to be very encouraging. B.J.

A82-13107 * **On-line optimization of aircraft altitude and flight path angle dynamics.** A. J. Calise (Drexel University, Philadelphia, PA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 1. New York, American Institute of Chemical Engineers, 1981. 6 p. (TA-1B). 5 refs. Grant No. NsG-1496.

The optimization of aircraft altitude and flight path angle dynamics is addressed in a form suitable for on-line computation and control. The approach here is a direct extension of the work reported by Calise (1979), where singular perturbation methods were used to optimize position, energy and heading dynamics; it thus represents an optimal control solution that models all of the primary trajectory related dynamics. It is pointed out that the resulting algorithm can be regarded as a nonlinear feedback control law. The minimum time intercept of a fixed terminal point is used in setting the framework in which the analytical results are developed. The main theoretical result is that the dynamics, while not completely separable, can be approximated by singular perturbation methods when the control model includes relative position dynamics. C.R.

A82-13115 * **Air-to-air combat analysis - Review of differential-gaming approaches.** M. D. Ardema (NASA, Ames Research Center, Moffett Field, CA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 9 p. (TP-1B). 15 refs.

The problem of evaluating the combat performance of fighter/attack aircraft is discussed, and the mathematical nature of the problem is examined. The following approaches to air combat analysis are reviewed: (1) differential-turning differential game and (2) coplanar differential game. Selected numerical examples of these approaches are presented. The relative advantages and disadvantages of each are analyzed, and it is concluded that air combat analysis is an extremely difficult mathematical problem and that no one method of approach is best for all purposes. The paper concludes with a discussion of how the two approaches might be used in a complementary manner. (Author)

A82-13119 * **On matching the systems identification technique to the particular application.** W. T. Suit and M. H. Mayo (NASA, Langley Research Center, Hampton, VA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981, 8 p. (TP-4C). 21 refs.

Several maximum likelihood and multiple regression parameter estimation programs are currently being used at the Langley Research Center of the NASA to analyze aircraft flight test data. Based on this wealth of experience, the pertinent features of these programs are investigated and some of the difficulties involved in their use are discussed. By comparing computational time, data requirements and accuracy needed, a strategy for determining which program can be used to the best advantage of the flight test engineer is discussed. (Author)

A82-13120 **Determining hinge moments and empennage airload parameters from flight data for Learjet airplanes.** G. D. Park and M. H. Abla (Gates Learjet Corp., Wichita, KS). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 6 p. (TP-4D). 8 refs.

Gates Learjet Corporation has utilized parameter identification techniques on flight test data in various ways to substantiate the airloads analyses used in certifying its airplanes. These analyses have concentrated primarily on the empennage and include: horizontal stabilizer rolling moment; vertical tail side load; horizontal tail actuator load; elevator, rudder and aileron pilot forces; and elevator hinge moment. Using the appropriate empennage loads results in conjunction with the results obtained from the total airplane responses, the component (wing-body, vertical tail, horizontal) airplane parameters were determined. The Taylor-Iliff computer program from NASA has been shown to be a very effective and efficient technique to substantiate airload analyses. (Author)

A82-13122 **Wing/store flutter - An active adaptive control application.** C. A. Harvey (Honeywell Systems and Research Center, Minneapolis, MN). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 3 p. (FA-1A). 9 refs. Research supported by Honeywell, Inc., Contracts No. F33615-77-C-3096; No. F33615-80-C-3217.

The paper briefly summarizes the results of a recent feasibility study and progress on a wind tunnel demonstration of digital adaptive control of wing/store flutter with regard to modern fighter aircraft. The design features of such a controller are examined, including sensor selection for feedback, detection, and discrimination, and two adaptive approaches, maximum likelihood estimation and self-tuning regulation. B.J.

A82-13125 * **The design of exact nonlinear model followers.** G. Meyer (NASA, Ames Research Center, Moffett Field, CA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 7 p. (FA-3A). 16 refs.

A practical approach to the design of control systems for strongly nonlinear, multivariable, time-dependent plants is described. The structure of the control system is that of an exact model follower. The model dynamics are decoupled, linear, constant, and of the order of the plant. The plant state and controls are transformed

so that the plant, when viewed through these transformations, looks like the simple model. Regulation of disturbances is accomplished by means of the transformed state and controls. Conditions for transformability into linear models, the appropriate models, and the construction of the transformations are discussed. The approach is illustrated on a trajectory autopilot for a helicopter. (Author)

A82-13128 An approach to robust nonlinear control design. M. K. Sain (Notre Dame, University, Notre Dame, IN) and J. L. Peczkowski (Bendix Corp., Energy Controls Div., South Bend, IN). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 6 p. (FA-3D). 18 refs.

The paper examines a control philosophy that linearizes the simulation at a finite number of points over the envelope of operation, that applies linear design technique locally about each such point, and that strings all the local designs together into a global design by scheduling the resulting compensations over the envelope as a function of key physical variables, and within a broad nonlinear model following strategy. Attention is given to the relevant local model following ideas, an extension of the local comparison sensitivity concept to the model following situation, and the global model following concept. A complete illustration based on a realistic nonlinear turbojet engine simulation is presented. B.J.

A82-13142 Fault detection for two physically separated, communicating inertial measurement units. P. Motyka (Charles Stark Draper Laboratory, Inc., Cambridge, MA). In: Joint Automatic Control Conference, Charlottesville, VA, June 17-19, 1981, Proceedings. Volume 2. New York, American Institute of Chemical Engineers, 1981. 10 p. (FP-2B) 6 refs. Contract No. F33615-78-C-1563.

The paper develops an analytic technique for the generation of failure detection and isolation (FDI) thresholds for a tactical aircraft system with two separated IMUs. The basic problem is to select thresholds which result in the detection and isolation of failures ranging from hard (those which affect flight-control performance) through midvalue (which affect pilot display performance) and soft (which affect navigation and weapon-delivery performance). FDI is accomplished by means of the generalized likelihood test. Results are presented which show the operation of the FDI system over a realistic flight profile, which incorporates maneuvers typical of a fighter aircraft mission. B.J.

A82-13150 # **Aeronautics in China - An AIAA report.** J. Grey. New York, American Institute of Aeronautics and Astronautics (AIAA Aerospace Assessment Series. Volume 4), 1981. 201 p. Members, $20.; nonmembers, $24.

Following the normalization of relations between China and the U.S., it was agreed that the Chinese Society of Aeronautics and Astronautics and the American Institute of Aeronautics and Astronautics would undertake an exchange of scientists and engineers to initiate the process of technical communication between the two nations in the field of aeronautics. This book reports the observations of the AIAA delegation which visited various aeronautical facilities in China. The history of Chinese aeronautics is considered along with aspects of aircraft production, engine production, and aerodynamics research, development, and testing. Attention is given to materials and structures, flight testing, guidance and control, computers, university educational programs, special topics, and aspects of travelling in China. G.R.

A82-13237 The Agusta A129. B. Lovera (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy). *Vertiflite,* vol. 26, Nov.-Dec. 1980, p. 6-9.

The design characteristics, performance capabilities and electronics systems of the A-129 light combat helicopter currently under development for Italian Army use are discussed. Attention is given to the aircraft's Integrated Multiplex System (IMS), whose functions fall into four categories: (1) the optimized interconnection of radios and navigation equipment; (2) the management of electrical power distribution, powerplant monitoring and control, and caution and warning; (3) the integration of motion sensors, digital stability augmentation systems, and flight director function; and (4) the operation of cockpit control and display elements, including flight management and radio control. The twin-turboshaft helicopter is primarily armed for the antitank role, with the TOW missile system mounted on stub wing pylons. Attention is also given to the airframe, mission equipment, and configuration flexibility of the aircraft. O.C.

A82-13238 Public service helicopters - Is the grass greener on the other side of the fence. T. R. Stuelpnagel. *Vertiflite,* vol. 26, Nov.-Dec. 1980, p. 10-13.

The impact on helicopter design of public service helicopter users, concerned with such tasks as law enforcement and public safety, search and rescue, wildlife and land management, fire fighting, medical services and disaster relief, is assessed in view of the present and growth markets they represent. New public service helicopter sales are estimated to be 5-10% of total commercial sales. It is recommended that public service helicopter users review their experience with each helicopter type employed and make their evaluations and requirements known to both the government and helicopter manufacturers on an annual basis. An awareness of helicopter equipment and configuration development would also be helpful, in order to propose the incorporation of features relevant to public service missions during the design phase of new helicopters, whose development cost is now on the order of $10,000 per pound of gross weight. O.C.

A82-13239 The TADS/PNVS 'eyes' for the AH-64 attack helicopter. B. J. Baskett, C. M. Tsoubanos, and V. M. Welner (U.S. Army, Aviation Research and Development Command, St. Louis, MO). *Vertiflite,* vol. 26, Nov.-Dec. 1980, p. 14-17.

The Target Acquisition Designation Sight (TADS)/Pilot Night Vision Sensor (PNVS) electrooptical subsystem of the AH-64 advanced attack helicopter is described, with attention to its Integrated Helmet and Display Sight System (IHADSS). The TADS provides the helicopter copilot/gunner with day, night, and adverse weather target search, detection and recognition capabilities by means of (1) direct view optics (DVO), (2) day television (DTV), and (3) forward looking infrared (FLIR) sighting subsystems, each subsystem being used singly or in combination depending on tactical, weather, or visibility conditions. The TADS also provides a laser designator to illuminate the target and guide HELLFIRE missiles, and a laser receiver which provides target range measurements for fire control computations. Samples of typical PNVS symbology, including heading, power management, airspeed, and radar altitude, are also given. O.C.

A82-13240 Fatigue methodology - A technical management system for helicopter safety and durability. L. L. Douglas. *Vertiflite,* vol. 27, Mar.-Apr. 1981, p. 14-17.

An account is given of the development since the early 19th century, of the technical disciplines comprising the field of fatigue-related structural safety as it applies to the design and maintenance of helicopters. Attention is given such milestones in the development of analytical methods for rotating machinery and vibration and flutter problems as N.O. Myklestad's (1944) 'A New Method of Calculating Natural Modes of Uncoupled Bending Vibration of Wings and other Types of Beams', as well as the related topics of the fatigue strength of materials and its improvement by surface treatment, stress concentration, cumulative damage and fatigue crack propagation. A review is also made of more recent developments in the design of fail-safe structures, the production of fracture-tough steel, aluminum and titanium alloys, and the application of composite materials to helicopter rotor blades. O.C.

A82-13241 Heavy lift helicopters - A national technology opportunity. G. H. Fries (Boeing Vertol Co., Philadelphia, PA). *Vertiflite,* vol. 27, May-June 1981, p. 14-17.

The mission requirements and possible design features of future heavy lift helicopters (HLH) in the 120,000 to 150,000-lb gross weight category are described. Attention is given to the military need for such helicopters in view of the U.S. Army's cancellation of the XCH-62 HLH project and the Soviet Union's reported development of the NATO code-named 'Halo' HLH, which has a lift capacity greater than that of any U.S. cargo helicopter. Consideration is given

to the relative advantages of the military, 'crane' configuration and those of a full-fuselage transport design with lower aerodynamic drag and greater productivity in longer-range missions. The transport fuselage configuration is also suited for short-haul commercial passenger service, with 140-150 seats initially and 225 seats in subsequent growth versions. Development-program cooperation between the Department of Defense and NASA is recommended. O.C.

A82-13242 The FAA's proposed helicopter certification rules. R. G. Schlegel (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT). *Vertiflite,* vol. 27, May-June 1981, p. 18-21.

A response is presented by the helicopter manufacturing industry to the FAA's Notice of Proposed Rule Making NPRM 79-13, 'Noise Standards for Helicopters in the Normal, Transport, and Restricted Categories'. Among the grounds cited for rejection are: (1) the proposed regulation sets limits that are too low, and incompatible with, the capabilities of existing technology for predicting and controlling helicopter noise; (2) regulation is premature at this time, because uncertainty as to the actual noise of the helicopters affected prevents a complete analysis of the regulation's economic impact; and (3) a loss of $8 billion in sales of current helicopter models could result from implementation of NPRM 79-13, with an additional $4.8 billion sales loss due to delays in the introduction of new helicopter designs. A joint industry/government program to establish the noise levels of all helicopters affected by the regulation is recommended. O.C.

A82-13243 Helicopter icing. A. A. Peterson and L. U. Dadone (Boeing Vertol Co., Philadelphia, PA). *Vertiflite,* vol. 27, May-June 1981, p. 22-25.

Due to the increased Instrument Flight Rules (IFR) capabilities of modern helicopters and the associated need for all-weather clearance, the U.S. Department and Defense and FAA are emphasizing helicopter icing investigations. Of all existing helicopters, only the Bell 412 is undergoing icing certification tests, and the SA 330 PUMA alone has obtained unlimited clearance for flight in forecast icing conditions. Consideration is given to the simulation of natural icing conditions by means of (1) icing wind tunnels; (2) environmental cold chambers; (3) helicopter tie-down sites that employ natural icing; (4) hover spray rigs; and (5) in-flight spray systems. Attention is also given to rotor ice protection systems, including those that employ high-resistance electrical heating elements, inflatable boots, microwave energy, controlled vibration, and such chemical freezing point depressants as glycol. O.C.

A82-13244 Light Airborne Multi-Purpose System. J. M. Purtell (U.S. Navy, Washington, DC). *Vertiflite,* vol. 27, Sept.-Oct. 1981, p. 10-13.

The Light Airborne Multi-Purpose System (LAMPS) MK III is the U.S. Navy's first fully integrated ship/air weapons system, combining frigates, destroyers and cruisers as platforms with Seahawk missile-carrying helicopters for the basic ASW mission. The helicopters also provide targeting data for Harpoon surface-to-surface missiles. The LAMPS ship/air system, which will involve over 100 ships and 204 aircraft over the next 25 years, will overcome four traditional weaknesses: (1) radar horizon limits, (2) sonar discrimination limits at extended ranges, (3) the range limitations of ASW weapons, and (4) limited missile-targeting ranges. Other elements comprised by the system are secure and open HF and UHF voice channels system management and control signal processors for the analysis of tactical data, and helicopter-delivered MK-46 ASW torpedoes. O.C.

A82-13245 Helicopter IFR - Past, present and future and future. V. E. Albert (Petroleum Helicopters, Inc., New Orleans, LA). *Vertiflite,* vol. 27, Sept.-Oct. 1981, p. 18-20.

An account is given of the developmental history and future prospects of helicopter Instrument Flight Rules (IFR) regulatory policies, flight instruments and procedures. The development of helicopter IFR has been speeded by British North Sea offshore oil drilling operations, whose helicopter service regularly encounters severe flying conditions. Among the problems encountered in the establishment of helicopter IFR in the U.S. have been the development of route structures to support such flights in the Northeast Corridor and Gulf Coast regions, the complexity of telephone and radio relay communications with air traffic controllers, and the establishment of weather stations. At present, in addition to the installation of offshore VHF radio stations in the Gulf of Mexico, a weather observation network and a route structure have been provided. The Loran Flight Following Program being tested at Houston station will provide remote areas with traffic separation services currently available only in urban areas, while costing only as much as two VHF remote radio locations. O.C.

A82-13246 Wire strike protection. C. Silvious (Tennessee Valley Authority, Knoxville, TN). *Vertiflite,* vol. 27, Nov.-Dec. 1981, p. 16-19.

Consideration is given to the design requirements of, and experience to date with, helicopter wire-strike protection devices made necessary by low-altitude operations in areas with extensive electrical transmission and communication lines. The tensile strengths of electrical transmission wires varies between 5000 and 233,000 lb, averaging 27,000 lb, and may become entangled in rotating parts even if successfully broken or cut by a helicopter. In addition to the education of pilots to better recognize wire strike hazards, attention is given to the use of wire-marking devices, which are useful in daytime operations, and the design of tail-rotor, main rotor and fuselage devices for cutting through or shielding against wires. It is recommended that all three measures be taken in future strike-reduction efforts by utilities and other helicopter operators. O.C.

A82-13314 Costs of noise nuisance from aircraft. P. W. Abelson (McQuarie University, North Ryde, New South Wales, Australia). *International Journal of Environmental Studies,* vol. 17, no. 3-4, 1981, p. 225-232. 10 refs.

The paper summarizes the results of research into aircraft noise costs around Sydney airport. The NEF (noise exposure forecast) model of noise annoyance is shown to provide a fair index of average, but not individual, attitudes toward noise. Although property prices were found to fall only by an average of 0.4% NEF, the fall per NEF is greater for higher values of NEF and for higher income households. However, household turnover rates due to noise, and therefore the costs of moving house, were found to be higher than those predicted by the Roskill Commission for the expected third London airport. Also, householders in noisy areas experience substantial losses in householder surplus, due in part to imperfect expectations of the noise effects. (Author)

A82-13451 Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. Conference sponsored by the American Institute of Aeronautics and Astronautics and Institute of Electrical and Electronics Engineers. New York, American Institute of Aeronautics and Astronautics, 1981. 645 p. Members, $65.; nonmembers, $75.

Digital avionics are discussed in terms of a system integration concept, fault isolation methodology, system effectiveness, advanced designs, sneak software analysis, and the pilot's role in an automated flight deck. Specific applications for the L-1011 flight control system, for hardware/software integration on the Shuttle, for one man operation of the F/A-18 Hornet, with voice command control, and for advanced weapons systems were considered. Papers were also presented on individual components of digital avionics systems such as the MIL-STD-1750 chip set, standardization and semiconductors, fiber optics, connectors for data buses, large screen CRT touch panels, an electronic terrain map, and flat panels for future military aircraft. D.H.K.

A82-13452 # Integrated avionics - Concepts and concerns. D. G. Botha (USAF, Avionics Laboratory, Wright-Patterson AFB, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 1-9. 14 refs. (AIAA 81-2211)

It is noted that the capability of avionics technology continues to increase by an order of magnitude every few years, but overall avionic system design architecture lags in the ability to fully exploit new technology and knowledge, particularly in the partitioning of the avionics-as-a-whole into subsystems for implementation by engineers in many disciplines, and in the integration of subsystems

into the whole. In this paper, it is suggested that a concerted effort is needed by the avionics community to reexamine system partitioning, considering the relationship of subsystems in the light of new operational concepts, new knowledge in information and control theory, and different concepts of integration such as multisensor information fusion and integrated control and display interface with the crew. B.J.

A82-13453 # **F/A-18A weapon system - 1976 state of the art.** R. C. Drummond (McDonnell Aircraft Co., St. Louis, MO). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, *Collection of Technical Papers.*
New York, American Institute of Aeronautics and Astronautics, 1981, p. 10-20. (AIAA 81-2215)

The F/A-18A system will perform both air/air and air/surface missions and has been designed for low operating and support costs through excellent reliability and maintainability. Advanced technologies include a one-man operable cockpit, using multifunction programmable CRTs and an automated hands-on-throttle-and-stick concept. Also included are a highly flexible radar using advanced digital processing and memory techniques, a programmable stores management set with multiplexed store stations, a quad-redundant electronic flight control system, and an expanded built-in-test capability. The design and performance features of the F/A-18A system are examined, and the future outlook is discussed. B.J.

A82-13455 # **Digital avionics - What a pilot expects to see.** R. A. Berube (Pan American World Airways, Inc., Miami, FL). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 28-38. 57 refs. (AIAA 81-2217)

The application of digital computers to aircraft is discussed from the pilot's point of view. Consideration is given to future digital design, human factors, cockpit instrumentation and predictive information, replication of the visual scene, display types, and performance/flight management systems. Particular attention is given to the importance of cockpit displayed traffic information. B.J.

A82-13456 # **Applications of digital avionics to commercial transport aircraft - The DC-9 Super 80 and beyond.** J. H. Shannon and J. D. McDonnell (Douglas Aircraft Co., Long Beach, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 39-46. (AIAA 81-2218)

The airlines' decade of experience with digital airborne equipment is reviewed, and some of the benefits arising from active controls, advanced cockpits, and advanced ATC systems that will be incorporated in the 1980's are described. This experience has given the airlines and manufacturers the confidence to further implement avionics systems with digital technology. The DC-9 Super 80 is now in revenue service with a digital flight guidance system, and other aircraft will soon enter service with the new ARINC 700 line of equipment. Additional benefits will be gained in the second half of the 1980's owing to both the cost-effective character of the equipment itself and the increase in efficiency of airframes and propulsion systems that can be obtained through further application of the digital equipment. B.J.

A82-13457 # **The role of avionics in the all electric airplane.** M. J. Cronin (Lockheed-California Co., Burbank, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, *Collection of Technical Papers.* New York, American Institute of Aeronautics and Astronautics, 1981, p. 47-55. 22 refs. (AIAA 81-2219)

The paper examines the role of avionics in the development of the all-electric airplane (AEP) as a viable and energy-efficient transport. It is noted that avionics will play a key role in the fuel and thrust management of the advanced-technology engines of the AEP via technology such as FADEC (full authority digital engine control). Attention is also given to the important role of avionics in the flight control of future AEPs, operating with a relaxed static stability and advanced supercritical wings. The samarium-cobalt motor/generator development and the proliferating use of power electronics for engine starting/motor control are also discussed. B.J.

A82-13458 # **Fault isolation methodology for the L-1011 digital avionic flight control system.** W. B. Noble (Rockwell International Corp., Collins Air Transport Div., Van Nuys, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 56-61. (AIAA 81-2223)

The operation of and rationale for the fault isolation/data display system for the L-1011 digital avionic flight control system are described. These systems are currently in service and are, despite the usual and expected introductory problems, providing substantial maintenance benefit. The English-language format chosen for the display as well as the storing of the squawk (or event) which accompanied each fault, have been instrumental in reducing maintenance confusion and false LRU removals. Present status mode is being used to solve a number of intricate maintenance problems in minutes, which previously required hours of troubleshooting time. B.J.

A82-13463 # **Avionics implications from weapon system operational utility studies on Manned Air Combat Simulators.** N. J. Kessler and H. Passmore (McDonnell Aircraft Co., St. Louis, MO). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 85-92. (AIAA 81-2230)

The McDonnell Aircraft Company Manned Air Combat Simulator (MACS) is described. The simulator facility is discussed, and a definition of the test models is given. In addition, attention is given to the lessons learned and system modifications which evolved as a result of this type of testing. It is noted that the value of MACS has recently been demonstrated as a tool for the evaluation in a simulated combat environment of the operational utility of such systems as the Advanced Medium Range Air-to-Air Missile (AMRAAM). B.J.

A82-13465 # **Computer-in-control selection logic for a triplex digital flight control system.** P. J. Ferreli (Boeing Military Airplane Co., Seattle, WA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 97-101. (AIAA 81-2236)

The computer-in-control logic (CICL) unit is an independent monitor that ensures proper selection of one of two flight control computers to the simplex level with minimum switching. The CICL maximizes fault tolerance without being a source of a single-point failure; its implementation is simple and reliable, and its algorithm is easy to change. This paper presents a functional description of the CICL and examines potential architectural considerations. B.J.

A82-13466 * # **Application of the concept of dynamic trim control and nonlinear system inverses to automatic control of a vertical attitude takeoff and landing aircraft.** G. A. Smith and G. Meyer (NASA, Ames Research Center, Moffett Field, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 102-115. 8 refs. (AIAA 81-2238)

A full envelope automatic flight control system based on nonlinear inverse systems concepts has been applied to a vertical attitude takeoff and landing (VATOL) fighter aircraft. A new method for using an airborne digital aircraft model to perform the inversion of a nonlinear aircraft model is presented together with the results of a simulation study of the nonlinear inverse system concept for the vertical-attitude hover mode. The system response to maneuver commands in the vertical attitude was found to be excellent; and recovery from large initial offsets and large disturbances was found to be very satisfactory. B.J.

A82-13467 # **Aircraft separation assurance avionics.** R. Sobocinski (Bell Aerospace Textron, Belmont, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19,

1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 116-118. (AIAA 81-2239)

Avionics sensors are under development to detect other transponder equipped aircraft. These sensors are subsets of systems postulated for the next generation aircraft. An Active BCAS system sponsored by the FAA interrogates, tracks and provides vertical collision avoidance commands. A Cockpit Display of Traffic Information (CDTI) sensor under NASA sponsorship passively detects transponder replies to ground based SSR sites. The CDTI provides a horizontal situation traffic display. This unit is being evaluated for pilot human factors interface. (Author)

A82-13468 # **Aircraft alerting systems standardization study.** G. P. Boucek, Jr., D. C. Hanson (Boeing Commercial Airplane Co., Seattle, WA), D. A. Po-Chedley (Douglas Aircraft Co., Long Beach, CA), B. L. Berson, M. F. Leffler (Lockheed-California Co., Burbank, CA), and J. F. Hendrickson (FAA, Washington, DC). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 119-128. 10 refs. FAA-supported research. (AIAA 81-2242)

The objectives of the Aircraft Alerting Systems Standardization Study were to augment the existing alerting system data base, to develop candidate alerting system concepts, to implement and validate these concepts, and to develop a set of alerting system guidelines and recommendations to standardize alerts on future electronic flight decks. This paper examines some of the more salient of these system guidelines and recommendations, which include: (1) that a functionally standardized alerting system be used on all future transport aircraft regardless of manufacturer, aircraft type, or airline operator; (2) that pilots audio/visual environment be improved by minimizing exposure to unnecessary or confusing alerts; (3) that three distinctively coded alert categories be provided to reduce uncertainty; and (4) that use be made of both visual and auditory channels to increase system effectiveness. B.J.

A82-13470 # **Design and analysis of a digitally controlled integrated flight/fire control system.** J. H. Blakelock (Applications Research Corp., Dayton, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 135-143. 7 refs. Contract No. F33615-78-C-3145. (AIAA 81-2245)

An integrated flight/fire control system including a movable gun and gimbaled line-of-sight tracker was designed using root locus techniques for the inner analog control loops and discrete analysis of the sampled-data outer control loops. The control systems designed include a pitch orientational control system with an outer attitude control loop, a beta/first time derivative of beta lateral stability augmentation system (where beta is the sideslip angle) with command yaw rate and a roll angle control system with an outer yaw attitude control loop, a velocity control system, a control loop for the movable gun, and the tracking control system. The discrete analysis was performed in the z-plane using traditional methods and in the s-plane using the Padé approximation. The gains for neutral stability and corresponding system natural frequencies predicted by both analysis techniques showed excellent correlation with the value obtained from a detailed six-degree-of-freedom hybrid simulation of the aircraft and various control systems. B.J.

A82-13471 # **Joint Tactical Microwave Landing System /JTMLS/ airborne signal processing.** R. J. Kelly and J. T. Skudrna (Bendix Corp., Communications Div., Baltimore, MD). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 144-155. 7 refs. (AIAA 81-2247)

The Joint Tactical Microwave Landing System, a lightweight transportable landing system which will provide all-weather precision approach guidance to drop zones, landing zones, and runways for MLS-equipped CTOL, STOL, VTOL, and rotary wing aircraft, is described with emphasis on the airborne avionics. It is shown how the airborne angle receiver satisfies the operational requirements by using an integrated digital avionics design and associated airframe antennas. This integrated avionics system will detect the MLS signal over a wide range of aircraft attitudes and will provide signal processing to generate lateral, vertical, and longitudinal guidance information for the complete spectrum of military FCS and cockpit displays. V.L.

A82-13472 # **LHX - An advanced avionics system design.** D. S. D'Avino (SEMCOR, Inc., Neptune, NJ) and S. S. Spiegel (SEMCOR, Inc., Moorestown, NJ). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 156-162. (AIAA 81-2249)

The paper reports results of a study which was performed with the objective of developing an avionics system concept for the LHX, an advanced Army weapons system. The preliminary results indicate that all currently defined LHX requirements for the armed scout mission are achievable using advanced technology and innovative system integration techniques. It is also shown that a one-man crew for the LHX is technically feasible. V.L.

A82-13481 * # **Have we overlooked the pilot's role in an automated flight deck.** G. G. Steinmetz, L. H. Person, and S. A. Morello (NASA, Langley Research Center, Hampton, VA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 222-227. 22 refs. (AIAA 81-2262)

Having adopted a philosophy of presenting situation information rather than command type as evidenced in flight directors and of keeping the pilot in a decision-making role, a series of simulation and flight experiments has occurred over a number of years as part of the Langley Terminal Configured Vehicle program. This paper traces the development, refinement, and integration of electronic pictorial displays, and a computer augmented velocity vector control mode. Some benefits and performances derived within the basic philosophy and information usage are brought forth in the discussion as results from the various simulator and flight evaluations are presented. (Author)

A82-13482 # **The application of large screen CRT's, touch panels, and voice to the flight stations of the 1990's.** R. L. Wasson and H. S. Archer, III (Lockheed-Georgia Co., Marietta, GA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 228-236. 5 refs. (AIAA 81-2263)

The paper examines how advances in technology, such as large screen displays, touch panels, and voice control affect the design of Lockheed's 1990's flight station. An integrated design embodying these concepts is presented and the advantages of such a design is explored. The paper is divided into two sections, the first addresses the inclusion of the advanced technology in the overall design of the flight station, and specific large screen display formatting, the second discusses the display/control technology necessary to implement such a design. (Author)

A82-13483 # **Electronic flight deck displays for transport aircraft.** R. A. Chorley (Smiths Industries Aerospace and Defence Systems Co., Cheltenham, Glos., England). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 237-246. 5 refs. Research supported by the Department of Industry and Ministry of Defence (Procurement Executive). (AIAA 81-2264)

Electronic flight deck and systems information displays for transport aircraft are discussed. Operational and economic advantages for military and civilian aircraft are reviewed, such as the flexibility of the display format which enables all information required for control of a transport aircraft to be displayed on the main panel, and the flexibility of the electronic system which minimizes the effects of failure within the display system. The display system configuration and the units of the electronic display system are presented, and human factors are considered. D.L.G.

A82-13484 # **F/A-18 'Hornet' - One man operability.** E. C. Adam (McDonnell Aircraft Co., St. Louis, MO). In: Digital Avionics

Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 247-251. (AIAA 81-2266)

Features of the F/A-18 fighter avionics design which allow one man operation in both fighter and attack modes are described. A CRT, along with head-up displays, provide the pilot with information essential for air-to-air, air-to-surface, and navigation modes. Pilot scan times are reduced because of information grouping and mission reliability is enhanced because of redundant image projection capabilities. The hands on throttle and stick system has an automated LOCK light for weapons delivery in a completely head-up, sensor-aided gun or missile attack. Console activity has been minimized through automation of time critical tasks, thus reducing the chances for pilot error or vertigo. A 98% failure detection and 99% failure isolation is built into the weapon system maintenance monitor panel. Operational capability is scheduled for 1983. M.S.K.

A82-13485 # **ARINC 429 digital data communications on the Boeing 757 and 767 commercial airliners.** R. K. Chun (Boeing Aerospace Co., Seattle, WA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 252-256. 5 refs. (AIAA 81-2267)

This paper will address the development and applications of the ARINC 429 digital data bus on the new generation of Boeing 757 and 767 commercial aircraft. The ARINC 429 Digital Information Transfer System (DITS) broadly defines a new digital data transmission format for avionics subsystems used in the next generation of commercial aircraft avionics applications. Boeing's development of a transmitter and receiver hybrid circuit which is compatible with ARINC 429 at the data bus interface will also be discussed. The hybrid package is hermetically sealed and designed to comply with the full range of military temperature requirements. (Author)

A82-13487 # **A polled contention multiplex system using MIL-STD-1553 protocol.** D. H. Wilson (Vought Corp., Dallas, TX). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 264-270. (AIAA 81-2271)

The polled contention mode in the Avionic Multiplex System is discussed, and a technique to pass the bus controller function between the terminals based on the activity of input data is presented. Improvements such as decreased data latency, more efficient bus utilization, and simplicity in software implementation are reviewed, and associated problems are considered. It is concluded that the use of dynamic bus allocation will have increasing significance as future systems become larger and more complex, while the polled contention mode may be a viable alternative to the command response system. D.L.G.

A82-13488 # **Avionics systems simulation for the Northrop F/A-18L aircraft.** R. A. Weeks (Northrop Corp., Hawthorne, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 271-278. (AIAA 81-2274)

A real-time, man-in-the-loop avionics systems simulation for the Northrop F/A-18L aircraft is discussed. Objectives include developing, implementing, and verifying the integration of the F/A-18L avionics systems with the human pilot. A fixed-based visual flight simulator with a high fidelity cockpit environment is used to assess pilot/system performance when subjected to multiple aircraft engagements, which provides operational characteristic simulations of the aircraft's radar, head-up display, integrated stores management, mission computer, and navigation systems. Consideration of the human pilot with the electronic systems allows early evaluations of potential problem areas, resulting in significant changes in the avionics systems. D.L.G.

A82-13490 * # **The SIFT computer and its development.** J. Goldberg (SRI International, Menlo Park, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 285-289. 8 refs. Contract No. NAS1-15428. (AIAA 81-2278)

Software Implemented Fault Tolerance (SIFT) is an aircraft control computer designed to allow failure probability of less than 10 to the -10th/hour. The system is based on advanced fault-tolerance computing and validation methodology. Since confirmation of reliability by observation is essentially impossible, system reliability is estimated by a Markov model. A mathematical proof is used to justify the validity of the Markov model. System design is represented by a hierarchy of abstract models, and the design proof comprises mathematical proofs that each model is, in fact, an elaboration of the next more abstract model. S.C.S.

A82-13498 # **The electronic terrain map - A new avionics integrator.** D. M. Small (USAF, Avionics Laboratory, Wright-Patterson AFB, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 356-359. (AIAA 81-2289)

The map reading process is a demanding task which can be simplified by using a digital map subsystem which accesses the information needed and presents it in a form which can be easily interpreted. An electronic map subsystem can generate perspective scenes, which are essentially computer generated images of the surrounding area, and an electronic map should be much easier to interpret. In addition, essential information from the map data base can be placed on the pilots Head Up Display, reducing the need for head down operations. Work on an all electronic map for aircraft display applications was started in 1976. The design and fabrication of an Airborne Electronic Terrain Map System (AETMS) was begun in May 1980. Requirements concerning future avionics systems are examined, and a future aircraft system is discussed. Attention is given to terrain following/terrain avoidance, threat avoidance, and navigation. G.R.

A82-13499 # **The interface of multifunction controls and displays to tomorrow's avionics.** W. G. Mulley (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 360-364. (AIAA 81-2290)

Approaches for keeping the cost of avionics systems at a lower level are considered, taking into account the use of systems which are easy to develop, produce, operate, and maintain. The solution of a maintenance problem includes operations related to recognizing a malfunction, isolating a malfunction, correcting a malfunction, verifying the correction, and documenting the maintenance action. The cockpit can be considered a computer terminal station, and it can become the maintenance shop for all the hardware in the particular aircraft. Five hardware interfaces and one software interface can completely define all hardware and software modules for the entire display and control subsystem. G.R.

A82-13500 # ***An update of an integrated CNI system - TIES.*** L. E. Smith and G. B. Heal (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 365-371. 9 refs. (AIAA 81-2292)

The Tactical Information Exchange System, TIES, is an integrated approach to providing the Communication, Navigation, and Identification (CNI) suite for future Naval aircraft. The system is based upon identifying the functional elements of a CNI suite and assembling them in a fashion that provides greater system reliability and availability over those currently available. TIES demonstration hardware is discussed, and the frequency conversion subsystem is considered, taking into account the HF site, the VHF/UHF site, and the Lx band site. Attention is given to the frequency division multiplex subsystem, the signal conversion subsystem, the TIES control subsystem, the data management and distribution assembly, the TIES external test, and questions regarding the further development of the TIES system. G.R.

A82-13502 # The use of separated multifunction inertial sensors for flight control. W. J. Luedde (McDonnell Aircraft Co., St. Louis, MO). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 377-382. (AIAA 81-2295)

The Multifunction Flight Control Reference System (MFCRS) program has the objective to verify that the outputs of inertial grade ring laser gyros and high quality accelerometers in a 'strapdown' configuration can be processed by a digital computer and used as the flight control feedback reference in a modern fighter, the F-15. To achieve these goals, a control law development study was performed to evaluate the effects of sensor location on flight control stability and performance. In addition, a redundance management algorithm, which uses parity equations, was developed to satisfy sensor selection and fault detection and isolation requirements. The MFCRS simulation model is considered, taking into account the F-15 flight control system, F-15 airframe dynamics, and an MFCRS sensor model. Attention is also given to sensor location studies, moment arm compensation studies, and aspects of simulator evaluation. G.R.

A82-13503 # Redundancy management of skewed and dispersed inertial sensors. D. L. Sebring (McDonnell Aircraft Co., St. Louis, MO) and J. T. Young (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 383-391. 13 refs. (AIAA 81-2296)

A redundancy management approach has been developed for strapped-down inertial instruments used as flight control reference sensors. The sensors will be installed and flight tested in a high-performance fighter aircraft (F-15) in a configuration consisting of two skewed and dispersed sensor clusters. Each cluster is an orthogonal triad of co-located, inertial-quality ring-laser gyros, and accelerometers. Two sets of logic (sensor selection and fault detection and isolation) operate in parallel, obtaining sensor selection and failure status information from stored tables. Table pointers are generated by comparing the values of parity equations to variable trip levels. An off-line, analytic computer program is used to generate the stored tables. This approach has been verified using Monte Carlo and F-15 Continuous System Modeling Program (CSMP) simulations. (Author)

A82-13504 # Development and laboratory test of an integrated sensory system /ISS/ for advanced aircraft. W. K. Toolan and A. M. Zislin (Grumman Aerospace Corp., Bethpage, NY). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 392-399. 8 refs. Contract No. N62269-79-C-0206. (AIAA 81-2297)

This paper presents the results of the second phase of an Integrated Sensory Subsystem (ISS) development effort performed by Grumman under contract to the Naval Air Development Center. The ISS is a combination of redundant inertial sensors, air data probes, transducers, and other flight control related sensors, interfaces, and the associated Data Handling System (DHS). The sensor data derived within the ISS meets the requirements (i.e., performance, redundancy, survivability, etc.) for Digital Fly-By-Wire (DFBW) flight control systems. The key issue of this development phase was the synthesis and development of a DHS for dispersed arrays of flight control inertial sensors subjected to dissimilar motions due to body bending of the aircraft structure. The system design is described in terms of the hardware and Data Handling System synthesis, followed by a discussion of the methods utilized to verify system performance. (Author)

A82-13505 # Direct digital drive actuation. L. L. Kohnhorst (Rockwell International Corp., Columbus, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 400-408. (AIAA 81-2298)

The Digital Flight Control System (DFCS) exploits the advantages of fly-by-wire mechanizations and digital technology while maintaining the demonstrated safety and reliability of manual control systems. However, the use of the DFCS would increase aircraft life cycle costs and decrease operational readiness if conventional avionic hardware configuration methods are applied to new aircraft designs. One of the programs initiated by the Navy with the objective to simplify the complexity of DFCS is related to the development of the Advanced Flight Control Actuation System (AFCAS). The AFCAS is to make use of a simplified, modular, fly-by-wire actuator. The simplified actuation can be accomplished without loss in mission reliability, but with improved mean time between failure (MTBF) because of the reduced complexity. The computer interface complexity is simultaneously reduced because of circuit requirements that are more compatible with digital technology than present day analog circuits. G.R.

A82-13506 # Applications of head-up displays in commercial transport aircraft. J. R. Lowe and J. R. Ornelas (Douglas Aircraft Co., Long Beach, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 409-414. 6 refs. (AIAA 81-2300)

The demanding tasks which the commercial transport pilot encounters during approach and landing are made easier by a suitable Head-Up Display (HUD) design. The HUD simplifies for the pilot tasks of decision-making, control and management. It also relieves him of the need to take his eyes from the view ahead to refer to his panel instruments. During an instrument approach, all guidance cues are available head-up whether or not any ground cues are visible. The continuously advancing state-of-the-art has improved the HUD with a larger field of view, more distinct images, and more easily followed symbology. These improvements have been made possible by advancements in HUD optic design, the use of the cathode-ray tube, the digital computer, and more sophisticated control laws. The first commercial transport HUD system in general use, now certified for the DC-9 Super 80, benefits from these improvements. G.R.

A82-13507 # Flat panel developments for future military aircraft. J. Brindle and W. G. Mulley (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 415-423. (AIAA 81-2302)

The four basic types of information for application in military aircraft are related to imaging or video, graphic, message, and discrete data. Various cockpit-mounted units are considered, taking into account the Head-Up Display, the Helmet-Mounted Display, the Mission Management Display and the Multifunction Programmable Keyboard. The display media employed include thin film electroluminescent devices, the light emitting diode, and the liquid crystal. Display addressing is discussed, giving attention to thin film transistor arrays, the integral silicon drive, the crossed electrode matrix, and the varistor. Plans for establishing technical requirements for each of the display system areas are also described. G.R.

A82-13508 * # An integrated control panel utilizing a programmable varistor-multiplexed dichroic liquid crystal display. I. J. Whitton (General Electric Co., Aircraft Equipment Div., Utica, NY). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 424-427. Contract No. NAS1-16414. (AIAA 81-2303)

Due to the conflicting demands of modern aircraft for increased systems/sensors and the decrease in cockpit panel size, weight, volume, and power, conventional discrete/dedicated methods of display and control are fast becoming obsolete. A means is sought to integrate the control and display into multifunctional programmable devices, thus giving the ability to increase system functions and yet conserve panel space. A potential solution to the control portion of the problem has come to be known as the Integrated Control Panel (ICP) approach. Flat panel display technology and controls using programmable flat panel displays with transparent capacitive touch control overlays offer the largest potential advantages. The flat panel display made of varistor-multiplexed dichroic liquid crystal (LCD)

developed by GE in recent years appears to offer the ideal monochrome solution. (Author)

A82-13513 # **Digital avionics display processor.** E. G. Hamilton, Jr. and S. H. Petrofsky (Emerson Electric Co., St. Louis, MO). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 466-472. (AIAA 81-2311)

This paper addresses the processing and display of the ever increasing amount of data from the new and sophisticated sensors currently being planned for aircraft use. Emphasis is placed on a display processor architecture designed for a multisensor environment. Detailed architecture description and some specific display and signal processing examples are included to illustrate data flow within this architecture. (Author)

A82-13514 # **Advanced display systems for crew stations of tactical aircraft.** W. G. Ast and D. E. Green (Loral Corp., Loral Electronics Systems Div., Atlanta, GA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 473-481. (AIAA 81-2312)

This paper describes the architecture and system characteristics of a family of intelligent operator/machine controlled Advanced Display Systems for use in modern tactical aircraft. A distributed processing communications link facilitates this type of a self contained control/display subsystem by minimizing demand on the central mission computer and providing flexibility in crew and cockpit display/control requirements. The major items of the Advanced Display System, including the Interactive Processing Terminal, the Universal Display Generator and the displays, are described in light of their features, capabilities and applications. The system is discussed from the standpoint of data load, timing constraints, display quality, dynamic performance and human factors. (Author)

A82-13515 # **Computergraphics for aircraft control.** S. F. Filarsky and W. G. Mulley (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 482-485. (AIAA 81-2313)

The Command Flight Path Display (CFPD) has been developed to demonstrate the feasibility of providing attitude, altitude, direction and speed command to the pilot in the form of an electronically generated presentation of the real world flight path which should be flown. The principal objective of the CFPD is to assure the precise and effective guidance and control of piloted aircraft at all times. The display system achieves this goal by computing the desired, or 'command' flight path and the deviations of the aircraft from that path, and then presenting a graphical representation of this combined 'director' and 'orientation' information to the pilot. Complete information on the attitude, altitude, speed and direction of the aircraft is presented continuously by the CFPD, whether the aircraft is under manual or automatic flight control. Therefore, the pilot is able to control all of the vehicle's six degrees of freedom by reference to the single, integrated display. The flight path display concept may be applicable to all phases of flight eventually, but the present developmental effort is confined to earth-referenced applications. Accordingly, the feasibility demonstration was limited to three such applications: takeoff, landing and fixed-target, air-to-ground attack. (Author)

A82-13516 * # **An advanced programmable/reconfigurable color graphics display system for crew station technology research.** R. J. Montoya (Research Triangle Institute, Research Triangle Park, NC), J. N. England (IKONAS Graphics Systems, Inc., Raleigh, NC), J. J. Hatfield (NASA, Langley Research Center, Hampton, VA), and S. A. Rajala (North Carolina State University, Raleigh, NC). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 486-498. 6 refs. (AIAA 81-2314)

The hardware configuration, software organization, and applications software for the NASA IKONAS color graphics display system are described. The systems were created at the Langley Research Center Display Device Laboratory to develop, evaluate, and demonstrate advanced generic concepts, technology, and systems integration techniques for electronic crew station systems of future civil aircraft. A minicomputer with 64K core memory acts as a host for a raster scan graphics display generator. The architectures of the hardware system and the graphics display system are provided. The applications software features a FORTRAN-based model of an aircraft, a display system, and the utility program for real-time communications. The model accepts inputs from a two-dimensional joystick and outputs a set of aircraft states. Ongoing and planned work for image segmentation/generation, specialized graphics procedures, and higher level language user interface are discussed. M.S.K.

A82-13517 # **Higher order Information Transfer Systems are coming.** J. W. McCuen (Hughes Aircraft Co., Fullerton, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 499-506. 11 refs. (AIAA 81-2317)

The functions necessary for airframe/weapons system integration in advanced avionics systems are reviewed, noting the relevance to the establishment of a military standard Information Transfer System (ITS). The requirements driving the changes from older avionics systems are listed, and the importance of hierarchical interconnections in multilevel, multiplexed ITSs to provide lower level ITSs with functionally isolated communications media whenever data interchange is needed is stressed. Flow diagrams for three- and two-level ITSs are provided; a topology of the designs includes functional isolation between critical flight subsystems. New subsystems such as fire control, stores management, weapon guidance, and release will be combined into one subsystem. Independently operating subsystem bus networks will be tied together by higher order systems operating between 1-50 MHz. M.S.K.

A82-13518 # **Advanced fiber optic systems for avionics applications.** B. E. Kincaid (Lockheed Research Laboratories, Palo Alto, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 507-513. 27 refs. (AIAA 81-2319)

The application of fiber optic (FO) systems to avionics is considered, with emphasis on the design of electronic warfare (EW) systems requiring high-speed, real-time data transfer busing and wavelength multiplexing. Single star, three in-line star, and three fully-interconnected star FO data bus architectures are compared with respect to optical loss equations, maximum number of terminals, number of required fibers and bulkhead connectors, optical dynamic range required, and multipath levels for interconnected loop architectures. It is found that the single star configuration is optically superior to the two alternatives, although simplex stars must be added to the single star in order to lessen the installation cost and reliability disadvantages associated with the configuration's large number of fibers and the large pin count in a bulkhead connector. O.C.

A82-13519 # **Light-guided information distribution systems.** H. P. Lavin (General Electric Co., Aircraft Equipment Div., Utica, NY) and G. B. Harrold (GE Electronics Laboratory, Syracuse, NY). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 514-521. (AIAA 81-2320)

This paper examines the pervasiveness of light-guided communication systems into the avionics interconnect system. The capabilities and limitations of current technology are presented together with system architectural alternatives such as the use of wavelength multiplexing of time division and frequency division signals with various modulating schemes. Transducer design techniques for the conversion from electrical to optical signals and optical to electrical signals are presented with some of the limitations of conventional analytical techniques. The extension of light-guided communications into the avionics backplane enhances system growth capability and technological transparency by information broadcasting among the

avionics modules. The experimental results of a preliminary light-guided backplane are presented using optics on a wire-wrap backplane to transfer digital clock, data, and control information for a maximum distribution to 40 loads. (Author)

A82-13520 * # On-board communication for active-control transport aircraft. L. D. Brock, A. L. Hopkins, Jr. (Charles Stark Draper Laboratory, Inc., Cambridge, MA), and J. L. Spencer (NASA, Langley Research Center, Hampton, VA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 522-529. Contract No. NAS1-15359. (AIAA 81-2321)

An investigation of active control communications sponsored by the NASA Langley Research Center is summarized. Particular attention is given to comparative architectures, for which a common set of requirements is generated as a baseline. Most of the requirements are aircraft functional in nature, such as stability and command augmentation, structural load relief, flight path control, flight control linkage, flight monitoring, management, navigation, engine control, and ground communication; the time element, the hazard environment, and the communications capacity estimation are also important factors. The architectures involve several communication technologies, including dedicated links, broadcast busing, and multiplex busing. The multiplex bus system provides the greatest flexibility and installation efficiency. A future homogeneous network system is also proposed, which would be fault and damage tolerant and would, with advanced technology, avoid the problems of designing a very large and flight critical multiplex bus system. J.F.

A82-13525 * # Digital detection and processing of laser beacon signals for aircraft collision hazard warning. L. M. Sweet, R. B. Miles, G. F. Russell, M. G. Tomeh, S. G. Webb, and E. Y. Wong (Princeton University, Princeton, NJ). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 563-571. 15 refs. Grants No. NCC2-94; No. NGL-31-001-252. (AIAA 81-2328)

A low-cost collision hazard warning system suitable for implementation in both general and commercial aviation is presented. Laser beacon systems are used as sources of accurate relative position information that are not dependent on communication between aircraft or with the ground. The beacon system consists of a rotating low-power laser beacon, detector arrays with special optics for wide angle acceptance and filtering of solar background light, microprocessors for proximity and relative trajectory computation, and pilot displays of potential hazards. The laser beacon system provides direct measurements of relative aircraft positions; using optimal nonlinear estimation theory, the measurements resulting from the current beacon sweep are combined with previous data to provide the best estimate of aircraft proximity, heading, minimium passing distance, and time to closest approach. (Author)

A82-13526 # An operational model of specific range for microprocessor applications in piston-prop general aviation airplanes. R. C. H. Parkinson. In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 572-579. 19 refs. (AIAA 81-2330)

This paper presents a fuel-efficient cruise performance model which facilitates maximizing specific range of General Aviation airplanes powered by spark-ignition piston engines and propellers. Airplanes of fixed design only are considered. Specific range is the ground distance the airplane flies per unit mass of fuel consumed in cruising flight. The cruise performance model determines the specific range, engine inlet manifold pressure, engine fuel-air mass ratio and engine fuel flow rate which correspond to any given values of geocentric true windspeed along track, equivalent airspeed, airplane gross weight, airplane longitudinal center of gravity position, auxiliary equipment power usage, engine rotational speed, pressure altitude and atmospheric ambient temperature. The use of the cruise performance model for maximizing specific range, with and without constraints on the airplane operation, is discussed. The cruise performance model appears suitable for airborne microprocessor implementation. Improvements in specific range, which are expected to result from implementation of the cruise performance model, are given. The principal hardware items necessary for such implementation are listed. (Author)

A82-13527 # Design and flight test of a lateral-directional command augmentation system. D. Atzhorn (USAF, Washington, DC) and R. F. Stengel (Princeton University, Princeton, NJ). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers.
New York, American Institute of Aeronautics and Astronautics, 1981, p. 580-592. 14 refs. Contract No. N00014-78-C-0257. (AIAA 81-2331)

Two-input/two-output lateral-directional control laws with Type 0 and Type 1 structures have been designed, analyzed, and flight-tested using the microprocessor-based digital flight control system (Micro-DFCS) installed in Princeton's Variable-Response Research Aircraft (VRA). These control laws were designed using linear-quadratic sampled-data regulator theory, and they were evaluated by U.S. Navy test pilots. Major closed-loop response features were found to be relatively insensitive to sampling rate (down to 4 sps), although flying qualities were degraded by increased sampling delay. Type 0 controllers provided satisfactory performance in flight, but the equivalent Type 1 systems were found to be unduly sensitive to disturbances and measurement noise. A novel application of the Tustin transformation proved useful in control law implementation. (Author)

A82-13529 # Fiber-optic immunity to EMI/EMP for military aircraft. M. K. Zaman (Lockheed-California Co., Burbank, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 597-599. (AIAA 81-2339)

Fiber-optic interconnect technology is specifically suited for military aircraft. This paper addresses a major factor of the fiber-optic interconnect technology, namely, the fiber-optic immunity to EMI/EMP, including power line transients and lightning strike. Transmission systems using fiber-optic cables (interconnect) are similar to those using electrical cables (balanced shielded twisted pairs), except that the output of the transmitter is used to modulate a light source. A photodetector responds to the light transmitted by the optical fiber, producing an electrical signal corresponding to the output of the modulated source. This signal can then be processed in a conventional manner in the system. In general, fiber-optic cables are not susceptible to EMI, provide good electromagnetic isolation between circuits, provide wide bandwidth, and are lightweight. Fiber-optic cable characteristics will be explored for shielding effectiveness. The EMI tests conducted to quantify the EMI benefits of fiber-optic cables in aircraft environments will also be discussed. No information related to transient radiation effects on electronics (TREE) is presented in this paper. (Author)

A82-13530 # Real-time flight management avionics software system. J. Chelini and R. H. Farmer (General Motors Corp., Delco Electronics Div., Goleta, CA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 600-607. (AIAA 81-2340)

Recently, the U.S. Air Force evaluated several varieties of Fuel Savings Advisory Systems (FSAS) including a Flight Management System (FMS) considered in the reported investigation. It is pointed out that the engineering effort to provide Flight Management Systems for commercial and military applications is extremely software intensive. To minimize software development efforts, an enlargement of the abstract computing machine was required. This resulted in the development of a kernel. A description is provided of the history associated with the development of a kernel and its use in FMS applications. It is demonstrated that through the use of solid software engineering methodology and proven operating system technology, Fuel Management System software is maintainable and error free, lending itself to a variety of configurations and demands with minimum software costs. G.R.

A82-13531 # Time-referencing of data in an asynchronous environment. B. D. Brumback (General Dynamics Corp., Fort Worth, TX). In: Digital Avionics Systems Conference, 4th, St. Louis, MO,

November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 608-613. (AIAA 81-2341)

The time-referencing of data in an avionic system that is based on asynchronous processing is discussed. The time-tag counter, provided by MIL-STD-1553B, is used to precisely define the age of data. An avionic system, which uses three asynchronous multiplex buses, is discussed as an example. A timing-uncertainty error budget is defined and the corresponding position and velocity errors are negligible when compared with the errors in a high-quality navigation sensor. (Author)

A82-13532 * # **A Loran-C prototype navigation receiver for general aviation.** R. W. Lilley and D. L. McCall (Ohio, University, Athens, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 614-620. 10 refs. Grant No. NGR-36-009-017. (AIAA 81-2329)

Investigations have been conducted regarding the techniques required for Loran-C navigation with application to the general-aviation pilot. The goal has been to produce prototype equipment for flight evaluation which will provide enroute navigation in both latitude-longitude and rho-theta coordinates and to evaluate the nonprecision approach capabilities of such equipment. In connection with the considered project, a prototype Loran-C receiver has been flight-tested using a variety of flight paths, with and without simultaneous ground radar position data collection. Attention is given to a receiver overview, an antenna preamplifier/coupler, the Loran-C receiver RF processor, the tracking loop hardware, tracking loop programming, video output, the laboratory and flight evaluation, and work currently in progress. G.R.

A82-13533 # **Advanced weapon systems - Integration technology.** M. J. Thullen (USAF, Avionics Laboratory, Wright-Patterson AFB, OH). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 621-628. (AIAA 81-2213)

The Digital Avionics Information System (DAIS) is discussed. DAIS has been characterized as a system architecture which can be applied and configured for a broad class of avionics applications and missions utilizing digital technology to reduce life cycle costs by defining and developing modular hardware and software core elements and standardized interfaces which can be configured and applied to many aircraft. The DAIS approach reflects a total system concept rather than a functional subsystem or hardware oriented system. The DAIS architecture consists of federated processors communicating with each other and the other system elements through a standardized multiplex data bus. Advanced avionics concepts are discussed, taking into account information fusion, functional automation, integrated subsystems, advanced architecture, and aspects of concept validation. G.R.

A82-13534 * # **Low cost programmable multisimulator facility.** J. G. Kreifeldt (Tufts University, Medford, MA). In: Digital Avionics Systems Conference, 4th, St. Louis, MO, November 17-19, 1981, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, 1981, p. 629-632. 7 refs. Grants No. NsG-2156; No. NCC2-93. (AIAA 81-2229)

A prototype, low cost multisimulator facility consisting of a DEC LSI-11 host computer and multiple desk top simulators is reported. The facility includes a main-frame system, a voice system, and a multi-cab system which consists of a flight panel, a host subsystem, and a flight simulator system. Software components are described, and the simulator computer, which provides flight dynamics, a path predictor, and navigation and data communications is discussed. The system may be computationally upgraded by specification of the DEC LSI-11/23, thus obtaining at least a two-fold increase in real-time computational power. D.L.G.

A82-13560 † **Divergence of a sweptforward wing (Divergentsiia kryla s obratnoi strelovidnost'iu).** A. P. Seiranian. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela,* Sept.-Oct. 1981, p. 133-138. 10 refs. In Russian.

Equations describing the divergence of a sweptforward wing are examined and found to contain a small parameter. The perturbation method for an arbitrary wing is used to obtain a formula relating the critical divergence rate with the basic characteristics of the wing. Numerical results are obtained using a variational method. P.T.H.

A82-13600 **Civil aviation in China.** R. Goodson. *Interavia,* vol. 36, Nov. 1981, p. 1098-1102.

An account is given of the present capabilities and development plans of the General Administration of Civil Aviation of China (CAAC), which has over 160 domestic routes, provides scheduled services to more than 80 Chinese cities, and operates 17 international routes. It is reported that, of the 120 airports in the People's Republic of China, only 12 can handle 707 airliner operations and less than 10 those of the CAAC's recently acquired 747SPs. Among the operational problems cited are the use of 24 different aircraft types and the acquisition cost of such advanced aircraft as the Airbus A300. Of great importance is the ability of the CAAC to purchase aviation fuel directly from the Chinese government, at prices 10-20% lower than those privately owned airlines pay. Attention is given to airport facilities, research and agricultural aircraft operations, and the effects of regional government policy. O.C.

A82-13701 † **Estimation of the efficiency of radioelectronic flight navigation systems (Otsenka effektivnosti radioelektronnykh pilotazhno-navigatsionnykh kompleksov).** M. S. Iarlykov and A. S. Bogachev. *Radiotekhnika,* vol. 36, Sept. 1981, p. 7-12. In Russian.

A method based on the theory of Markov processes is developed for estimating the efficiency of flight navigation avionics. System components are modeled with three states, which makes it possible to investigate the permanent and temporary malfunctions. Particular attention is given to the selection of a criterion for the operational efficiency of the navigation system, and to the determination of operational states of the system. B.J.

A82-13703 † **Digital signal processing on a background of rereflections for the international aircraft landing system (Tsifrovaia obrabotka signala mezhdunarodnoi sistemy posadki samoletov na fone pereotrazhenii).** A. K. Berniukov. *Radiotekhnika,* vol. 36, Sept. 1981, p. 26-29. 7 refs. In Russian.

An analysis of multibeam signals in the time-reference scanning-beam (TRSB) system is presented for the case of rereflections and minimum a priori information. Algorithms of real-time digital processing are proposed, which make it possible to discriminate the signal from the rereflection, and to measure the information parameter. B.J.

A82-13852 * # **Powered-lift takeoff performance characteristics determined from flight test of the Quiet Short-haul Research Aircraft /QSRA/.** D. W. Riddle, R. C. Innis, J. L. Martin, and J. A. Cochrane (NASA, Ames Research Center, Moffett Field, CA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2409.* 14 p. 12 refs.

A powered-lift, reduced thrust takeoff performance program utilizing quiet short-haul research aircraft has been conducted. It has been shown that the powered-lift upper surface blowing concept greatly enhances aircraft takeoff performance. The improvements include: (1) takeoff field lengths may be shortened by approximately 30%; (2) Air Force critical field lengths may be shortened by approximately 60%; (3) powered lift upper surface blowing aircraft have better handling and performance characteristics than comparable conventional aircraft; and (4) the low speeds associated with powered-lift takeoff enhance safety margins. S.C.S.

A82-13853 * # **Thunderstorm hazards flight research - Program overview.** P. L. Deal, G. L. Keyser, B. D. Fisher, and N. L. Crabill (NASA, Langley Research Center, Hampton, VA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2412.* 11 p. 7 refs.

The NASA thunderstorm hazards research program, designed to study the effects of lightning strikes on the design and operation of aircraft, is described. An all-weather F-106B is instrumented to document the EM characteristics of direct and nearby strikes, measure the field parameters and analyze the ambient atmospheric

content, and film the strikes; X-ray detectors are also on board, along with instrumentation for determining the frequency of visible light waveforms. Data is either recorded on-board or sent by telemetry to base, while ground based telemetry is used to direct the pilot and craft into regions of optimal lightning activity. The sensing apparatus is described, and ongoing programs to correlate different storm parameters are reviewed, along with operational procedures and safety precautions. Continued use of the craft through 152 storms and 16 direct hits, with no fatalities or circuit breaker throw, confirms the ability of metal skinned aircraft to withstand lightning strikes; data gathered from flights during 1980 are provided. D.H.K.

A82-13854 # **Enhanced F-15 air-to-ground flight demonstrations.** G. D. Gibbs (McDonnell Aircraft Co., St. Louis, MO). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2413.* 6 p.

Features designed to enhance the F-15 Eagle air-to-ground capabilities are presented. The F-15, intended to provide battlefield air superiority, has a thrust/weight ratio exceeding one-to-one; its armament systems are outlined. Built-in flexible digital avionics have allowed in-weather performance using synthetic aperture radar (SAR), high resolution mapping, and incorporation of an infrared laser sensor pod for use once in target range. The SAR has a resolution of 8.5 ft at 10 miles, suitable for detecting surface vehicles. The flight range has been extended with conformable fuel tanks, which, though adding a small drag increase beyond Mach 1, has doubled the internal fuel capacity; a full fuel load is now 5,120 gal, enough for more than a transatlantic flight. Two seven in. and four two in. CRT displays have been mounted in the aft cockpit, which now has complete flight control capability. Patch mapping, target identification, and blind bombing test flights are described. D.H.K.

A82-13855 # **The F-16/79 test program.** K. G. Timpson (General Dynamics Corp., Fort Worth, TX). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2414.* 8 p.

Flight certification testing for the F-16 fighter outfitted with a J79 engine (F16/79) is described. The use of the J79 engine required a new inlet, a new secondary air variable by-pass system, nacelle structural insulation blankets, and adaptation of the fire detection system and installation of a fire extinguishing system. The tests were concerned only with systems which were affected by the change of engine; 350 test runs were flown. Flight test procedures are outlined, chronography is provided, and instrumentation for real-time telemetry is discussed. A total of thirteen months elapsed between the decision to outfit the export version of the F-16 with a different engine and the completion of the flight certification trials; the results of the tests are now under review by the Air Force. D.H.K.

A82-13856 # **Organizing and training for innovative flight test management.** J. D. Lang (USAF, Wright-Patterson AFB, OH). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2416.* 8 p. 6 refs.

The organization and training for innovative flight test management by the 4950th Test Wing is reported. Current wing structure, methods, planned changes, and employer/employee relationships are discussed. An in-house training program to assist in the transition from old to new by enhancing attitudes and clarifying roles for improved leadership in test project and test engineering management is presented. Future emphasis is also discussed, and is to be on organizational attitude to encourage innovation and motivation to make each project succeed. D.L.G.

A82-13857 * # **Flight experience with a remotely augmented vehicle flight test technique.** K. L. Petersen (NASA, Flight Research Center, Edwards AFB, CA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2417.* 19 p. 7 refs.

A flight technique which uses the remotely augmented vehicle (RAV) concept is developed to flight test advanced control law concepts. The design, development and flight test validation of a RAV system mechanized on a digital fly-by-wire aircraft are described, and future applications are discussed. Flight experiments investigate complete inner loop, low sample rate, and adaptive control system mechanisms. The technique, which utilizes a ground-based FORTRAN programmable digital computer and up and down telemetry links is found to provide the flexibility necessary to effectively investigate alternate control law mechanisms in flight. D.L.G.

A82-13859 # **A technique to determine lift and drag polars in flight and their application.** A. Knaus (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2420.* 13 p.

The paper presents performance trials of the European combat aircraft Tornado, which concentrate on techniques used to measure lift and drag polars. The polars are measured by means of well adapted test instrumentation, a data reduction system, and a high calibration standard for the aircraft and engines. Steady state and dynamic test maneuvers are combined, and result in a significant reduction in flight time required to obtain sufficient data for determining zero lift drag, induced drag characteristics, and drag increments due to aircraft configuration change. Flight test results are presented, which demonstrate the advantages of the test technique, the high data quality, and the feasibility of in-flight verification over the entire angle of attack range. D.L.G.

A82-13861 # **A cost effective method for the control of roll due to side slip on a low speed aircraft.** S. Chandrashekar and N. S. Kiran (Hindustan Aeronautics, Ltd., Flight Test Dept., Bangalore, India). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2422.* 5 p. 5 refs.

Dihedral effect and its control are important for increasing damping of dutch roll, as well as reducing roll damping and unstable spiral modes. The effectiveness of setting the wing-tips at large anhedral angles to reduce the dihedral effect is demonstrated for the case of a low wing piston trainer with a positive geometric dihedral. Results of flights conducted with four wing-tip an/dihedral values showed that the effective dihedral changed its sense when the aircraft was flown with a 30 deg wingtip anhedral; this change in sense occurred at about 10 deg tip-anhedral. The method was found to be both time and cost effective compared with conventional methods. Lack of agreement with analytical estimates indicates the need to review the analytical methods, which were based on results from wind tunnel measurements. J.F.

A82-13863 # **Performance estimation from non-steady manoeuvres.** K. R. Nippress (Aeroplane and Armament Experimental Establishment, Boscombe Down, Wilts., England). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2424.* 11 p.

Data obtained from non-steady manoeuvers on modern high performance aircraft have been analysed using least squares regression techniques to produce thrust drag models of the aircraft. Predictions of level speed performance, climb performance and turning performance have been produced from the model data and compared with data obtained from traditional test methods. The results presented in this paper demonstrate that use of non-steady techniques offers the possibility of decreasing the flight time required to perform a performance evaluation to approximately one quarter of the time required by traditional steady techniques. (Author)

A82-13869 # **Navy performance modeling techniques.** R. W. Boyd (U.S. Navy, Naval Air Test Center, Patuxent River, MD). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2431.* 5 p.

Details of airframe/engine/installation models combined with flight test data to achieve accurate performance modeling are presented. The airframe performance (drag) and engine performance (thrust) have separate computer programs which accompany the components from initial design to flight testing, and are updated with each modification to the hardware. Wind tunnel and flight test measurements are input as drag parameters while engine operational

parameters are input into the thrust model. Once installation has been accomplished, a flight test model is developed which must be overlaid with the data from the initial thrust and drag models. A flowchart is presented for performance modeling, and the maneuvers and acceleration tests are described; the performance model is fed into a computer with graphics capability for analysis by project engineers. M.S.K.

A82-13871 * # HiMAT aerodynamic design and flight test experience. N. W. Matheny (NASA, Flight Research Center, Edwards AFB, CA) and G. N. Panageas (Rockwell International Corp., North American Aircraft Div., Los Angeles, CA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2433.* 18 p. 5 refs.

Consideration is given to the design phase of the highly maneuverable aircraft technology program. Design objectives are examined, noting full-scale design and the remotely piloted research vehicle. Attention is given to subsonic, transonic, and supersonic design. Design results are discussed with reference to aerodynamic efficiency, aeroelastic tailoring, and the flight test program. S.C.S.

A82-13872 # In-flight computation of helicopter transmission fatigue life expenditure. K. F. Fraser (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2434.* 10 p. 5 refs.

Estimates of the safe fatigue life of critical helicopter transmission components may be made if in-service load data together with component fatigue data are available. Instrumentation has been developed to provide in-flight computation and indication of the current values of fatigue life expended for critical gears in single or twin-engine helicopter transmission systems. In addition basic transmission load data in the form of totalized times spent in a number of contiguous torque bands are continually updated and stored during flight. The basic load data together with values of life expenditure for critical gears for the current flight can be automatically printed out after flight. This development opens the way towards fatigue life monitoring of individual transmissions. (Author)

A82-13873 # Advancing blade concept /ABC/ development test program. A. J. Ruddell (United Technologies Corp., Sikorsky Aircraft Div., West Palm Beach, FL). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2437.* 10 p. 10 refs.

The Advancing Blade Concept (ABC) rotor system derives its name from the fact that the predominant lift load at high forward speeds is carried by the advancing blades on both sides of the aircraft. Since the retreating blades are not required to carry a significant fraction of the total lift load at forward speed, the speed and load factor limitations of the conventional helicopter due to retreating blade stall are eliminated. ABC development began in 1964. The XH-19A ABC demonstrator aircraft was designed as a research tool to investigate the ABC rotor characteristics. A brief review of the concept principles is presented along with a description of the test aircraft. It is pointed out that the XH-59A flight program has completed a successful demonstration of the ABC rotor system. The XH-59A has demonstrated significant maneuver and performance improvements over conventional helicopters. G.R.

A82-13874 * # Recent propulsion system flight tests at the NASA Dryden Flight Research Center. F. W. Burcham, Jr., L. P. Myers, J. Nugent, P. L. Lasagna, and L. D. Webb (NASA, Flight Research Center, Edwards AFB, CA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2438.* 13 p. 13 refs.

The article presents a summary of the propulsion system tests conducted on a number of aircraft at the NASA Dryden Flight Research Center. The tests included digital engine control systems, engine-inlet compatibility, inlet-airframe interactions, nozzle-boattail drag and advanced turboprop acoustics. Among the aircraft evaluated were the F-15, HiMAT, F-14, and the JetStar. S.C.S.

A82-13875 # C-5A unsurfaced taxi and off-load demonstrations. R. A. W. Brown (Lockheed-Georgia Co., Engineering Flight Test Div., Marietta, GA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2439.* 10 p.

The results of tests to evaluate the C-5A maneuvering and off-load capabilities on unsurfaced soils are presented. Clay-sand, sand, and silty clay soils with a CBR of nine were chosen for runways for the 665,000 lb fully loaded vehicle. Weight was gradually built up to the maximum, using a field with drop-offs no greater than six in. and driving at 5-10 knots. Conditions were created for dry sand, wet ground, snow, and frozen soil. Maneuvering was accomplished in ruts up to 8 in. deep in loose sand and 15-21 in. deep in snow; towing was not considered essential because the C-5A has rolling, rather than powered, wheels. The C-5A was judged operable under the test conditions, and recommendations are given for expanding the number of airfields available for the C-5A by using methods developed in the present tests as reference marks for soil evaluation. D.H.K.

A82-13876 # The Cessna T303 Crusader. T. E. Wallis and M. O. Schlegel (Cessna Aircraft Co., Wichita, KS). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2440.* 7 p.

The Cessna T303 Crusader is a six-place twin with a gross weight of 5150 pounds and an IFR equipped useful load of over 1850 pounds. Extensive initial computer and wind tunnel studies have resulted in an airplane with truly superb flying qualities. A cruciform tail configuration with a high aspect ratio horizontal tail, and advanced flow control devices in critical areas contribute much to these characteristics. The turbocharged 250 bhp engines have a unique turbocharger/compression ratio combination which provides excellent fuel economy. The paper describes the airplane and the development and certification flight test program. (Author)

A82-13877 # Government testing. J. C. O'Connor (U.S. Army, Aviation Research and Development Command, St. Louis, MO. *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV. Nov. 11-13, 1981, AIAA Paper 81-2443.* 4 p.

The Department of Defense Directive on Test and Evaluation establishes the policy of conducting test and evaluation throughout the acquisition process of a defense weapon system. The acquisition process consists of four distinction phases, with each phase requiring a particular scope and type of test. This paper addresses the flight testing required for each acquisition phase during the development and production of Army aircraft. The test objectives, scope of tests, and test methodology are presented for the Preliminary Airworthiness Evaluation, Developmental Tests, Operational Tests, artificial/natural inflight icing, climatic laboratory tests, and the Airworthiness and Flight Characteristics Tests. (Author)

A82-13878 * # Flight test method for the determination of reciprocating engine cooling requirements. S. J. Miley, E. J. Cross, Jr. (Texas A & M University, College Station, TX), and D. L. Lawrence (Piper Aircraft Corp., Lakeland, FL). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2446.* 6 p. Grant No. NsG-1083.

It is pointed out that the effective cooling of aircraft reciprocating engines is still a problem area for the general aviation industry. Miley et al. (1981) have reported the results of an investigation of problems associated with cooling and installation aerodynamics. A description is given of a flight test procedure which was developed in connection with the considered investigation. It is shown that the test procedure provides valid cooling requirements data for a particular installation. The data are in terms of easily measurable parameters. The employment of the test procedure, which is based on the NACA cooling correlation method, can lead to more effective cooling installations and the solution of existing cooling problems. G.R.

A82-13879 # Performance assessment of an advanced reheated turbo fan engine. V. Zeidler (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2447.* 15 p.

Testing and evaluation techniques for rating the performance of

an advanced reheated turbofan engine are reported. Thrust, specific fuel consumption, and engine operational qualities are calculated for input into a computer. Thrust evaluation requires gross thrust and air mass flow measurements, which are taken as far as possible downstream from the engine, and are linked as input. Other options for thrust evaluation are described, noting that each possesses slight degradations in accuracy. Calibration curves are diagrammed for each option, and the performance evaluation of convergent nozzles is outlined. Calibration runs are performed in an altitude test facility (ATF) with totally controlled inputs to simulate the conditions in which test flights will be flown. Highest accuracy is obtained using linked methods and two engines in the ATF for performance and aircraft drag evaluation. M.S.K.

A82-13880 * # **Selected stability and control derivatives from the first Space Shuttle entry.** K. W. Iliff, R. E. Maine (NASA, Flight Research Center, Edwards, CA), and D. R. Cooke (NASA, Johnson Space Center, Houston, TX). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2451*. 16 p. 10 refs.

Primary stability and control derivative estimates garnered from the first Shuttle entry are reported. The craft was the first vehicle to maneuver over a wide range of hypersonic velocities, yielding data on flight characteristics from previously unexplored regimes. The flight envelope was confined to entry and safe landing, with no additional maneuvers to gain control data. Data for a Mach number range of 25-1.5 and altitudes of 515,000-50,000 ft are provided, and functional ranges of the Shuttle control surfaces and attitude jets are outlined. On-board systems gathered data on aerodynamic coefficient identification, flight condition and Euler angles, and jet chamber pressures. A maximum likelihood estimation program, which contained unknown stability and control derivatives, was used for control; a control input determined the value of the unknown derivatives, and the input and spacecraft response were measured. Longitudinal and lateral directional maneuvers and their derivative estimates are described, noting wind contamination of the sideslip measurements below Mach 3. Further maneuvering and stability tests are projected for subsequent flights. M.S.K.

A82-13881 # **Planning a helicopter flight test program.** K. Kuppuswamy and N. S. Kiran (Hindustan Aeronautics, Ltd., Flight Test Dept., Bangalore, India). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2381*. 6 p.

A study has been undertaken to assess the feasibility of completing the flight test program for the three different prototypes of the Advanced Light Helicopter, a high-performance twin-jet craft designed to operate under Indian conditions, within the 30 months allotted for the purpose. It was found that in order to achieve the 1000 hours of flight time required, all prototypes must carry identical instrumentation packages capable of making about 100 different dynamic, quasi-static and identifying measurements, with a fourth package as backup. Analysis of the weight of such an instrumentation package indicates it to contribute about 400 kg to the weight of the helicopter, with one third of the total represented by cables and connectors. Cost estimates reveal over 50% of the program cost per flight hour to be accounted for by insurance and depreciation, while the more controllable engineering and flying costs make up only 33% of the total. Finally, a study of expected reliability, availability and maintainability of the test vehicle, airborne data acquisition system and telemetry system reveals that they are compatible with the planned schedule. S.C.S.

A82-13888 # **Recent improvements at the Naval Air Test Center for increased test system flexibility.** T. F. Coyle, G. A. Davis, and G. R. Ryan, Jr. (U.S. Navy, Naval Air Test Center, Patuxent River, MD). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2392*. 10 p.

Improvements that have been made in two real-time systems used daily at the Naval Air Test Center are described. The systems are the Real-time Telemetry Processing System (RTPS) and Range Computation and Control System (RCCS). The improvements have made possible (1) rapid changes to real-time application programs; (2) increased flexibility in data reduction; (3) increased capability in data analysis; and (4) increased capability in range control systems. It is pointed out that these improvements will enable the RTPS and the RCCS to provide the necessary support for the test and evaluation of both vehicles and mission systems at the center in the 1980's. C.R.

A82-13891 # **Flight testing the nonmetallic spline coupling technology at the Naval Air Test Center.** P. F. Zalesak, Sr. (U.S. Navy, Naval Air Test Center, Patuxent River, MD). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2405*. 12 p. 18 refs.

Results of a flight test program are discussed and data are presented in support of the contention that the nonmetallic spline coupling technology can be used to reduce unwanted oscillatory torsional loads transmitted between components. It is shown that the nonmetallic spline coupling technology can be applied to existing hardware systems to improve the reliability of components used to transmit torque. In the test, transmitted torsional load data, as measured at the engine driven compressor test drive shaft, were collected during several flight phases, including takeoff, takeoff abort, negative torque system check, loiter flight conditions at 500 feet and 200 knots indicated airspeed, inflight engine shutdown, inflight engine start up, landing and ground backing up operations. C.R.

A82-13892 # **Commentary on facilities used in the development of a Sea Harrier all weather operations capability.** J. W. Britton (Royal Aircraft Establishment, Bedford, England). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2407*. 8 p.

The resolution of difficulties inherent in developing an all-weather V/STOL aircraft (Sea Harrier) for sea operations is described, along with the test facilities used for the program. Reduced visibility, which restricts pilot instrument use after a certain point while landing, were explored with flight simulators with four-axis motion. The simulator provided motion fidelity, head-up displays, realistic visual and environmental conditions (digital computer controlled), and a TV video system. Additional flight test use was made of a Harrier two-seater equipped with blinds to alter visibility. Visual guidance aids comprising flashing red and white lights and runway markers were employed to provide strong visual cues for pilot orientation during approach. The advantages of having all equipment on-site are stressed, as data from one test is then available for simultaneously run test phases. D.H.K.

A82-13894 # **Information technology and its impact on test and evaluation at the Naval Air Test Center.** R. K. Fairfax, T. C. Lancaster, and G. F. Hurlburt (U.S. Navy, Naval Air Test Center, Patuxent River, MD). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2396*. 7 p. 13 refs.

An investigation is conducted regarding the approaches used by the Naval Air Test Center to provide data collection, reduction, and computer support requirements for full-scale aircraft development programs such as the F/A-18, AV-8B, and LAMPS MK-III. Aspects of initial real-time development are discussed, taking into account network components, the data transmission network, the fiber optic cable, the interface equipment, the real-time processor, telemetry application, questions of range application, and problems of graphics application. A description of a satellite communications demonstration is also provided. G.R.

A82-13898 # **Georgia Tech coherent jammer flight test.** H. W. Andrews and D. L. Gordon (Georgia Institute of Technology, Atlanta, GA). *AIAA, SETP, SFTE, SAE, ITEA, and IEEE, Flight Testing Conference, 1st, Las Vegas, NV, Nov. 11-13, 1981, AIAA Paper 81-2452*. 7 p.

A test program to accurately measure the interaction between a coherent jammer and a radar is described. Theoretical calculations comprised finding closed form solutions for the jammer/radar interaction, and considered slant range antenna patterns, radar cross section, frequency, polarization, and scenario geometry, in addition to the development of computer programs to study electronic countermeasures techniques. A jammer was devised to meet the specifications derived from the analytical work and mounted on a test aircraft with 14 track analog pulse-to-pulse recording equipment.

The data acquisition systems and data flow are diagrammed and experimental procedures are outlined for a radar pulse ratio frequency of 2800 Hz and a pulse width of 0 5 microsec The plane will follow head on zig-zag and constant off set flight paths toward the radar to test the jammer capabilities D H K

A82 13903 # **Fleet Flight Loads Survey monitoring and analysis techniques** D A Rakin (Grumman Aerospace Corp Bethpage NY) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2461* 12 p

The F 14 Fleet Flight Loads Survey program collected data from operational fleet aircraft for the generation of full scale fatigue test spectra and fatigue design criteria Thirty five channel tape recorders were installed in each of four fleet aircraft to measure aircraft kinematic parameters surface position and airframe strains Computer software was developed to reduce the data to the form of exceedance plots and bivariate exceedance tabulations Regression equations were generated from structural flight test data and used to generate exceedance plots of major airframe surface loads J F

A82 13906 * # **Flight test experience with high-alpha control system techniques on the F 14 airplane** J Gera R J Wilson E K Enevoldson (NASA Flight Research Center Edwards CA) and L T Nguyen (NASA Langley Research Center, Hampton VA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2505* 22 p 5 refs

Improved handling qualities of fighter aircraft at high angles of attack can be provided by various stability and control augmentation techniques NASA and the U S Navy are conducting a joint flight demonstration of these techniques on an F 14 airplane This paper reports on the flight test experience with a newly designed lateral directional control system which suppresses such high angle of attack handling qualities problems as roll reversal wing rock, and directional divergence while simultaneously improving departure/spin resistance The technique of integrating a piloted simulation into the flight program was used extensively in this program This technique had not been applied previously to high angle of attack testing and required the development of a valid model to simulate the test airplane at extremely high angles of attack (Author)

A82 13907 # **Flight testing De Havilland Aircraft Limited DASH 8 utilizing onboard data analysis by microprocessor** W M Gibson (De Havilland Aircraft of Canada Ltd Downsview, Ontario, Canada) *AIAA SETP SFTE SAE ITEA and IEEE FLight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2507* 8 p

The DASH 8 is a 30 to 36 passenger high wing T tail STOL airliner powered by two turboprop engines driving hydromatic four bladed propellers with full blade angle control The aircraft is designed to meet commercial market requirements in the passenger cargo and executive transport roles with concentration on aero dynamic cleanliness to produce an energy efficient aircraft with low operating costs The STOL criteria are related to requirements for a 3000 ft field length A microprocessor was selected to perform the onboard data analysis task for the DASH 8 Attention is given to the basic instrumentation system the microprocessor data stream inter face data analysis by onboard computer and examples of onboard data analysis G R

A82 13908 # **Application of a microprocessor controlled cockpit display for enhanced pilot control of flight test maneuvers** M J Burke and E W Ferris (Grumman Aerospace Corp , Calverton NY) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV, Nov 11 13 1981 AIAA Paper 81 2510* 4 p

Pilot 'overshoot of the desired flight test conditions due to malfunctioning or inadequate cockpit displays has been a continuing problem In addition monitoring multiple parameters during dy namic maneuvers is difficult for the pilot Structural flight testing utilizes indirect parameter ('g) for actual structural strain values resulting in poor predictability of strain values during a maneuver A Microprocessor Crew Display (MCDS) was generated to meet this need It consists of a 'bargraph' light emitting diode display two CRT s and a caution/warning light A total of five parameters can be selected and displayed at one time Flight experience with the MCDS indicates more precise and quicker control of the aircraft, reduced probability of 'overshoot increased flight safety and reduced flight test time (Author)

A82-13910 * # **Direct strike lightning measurement system** M E Thomas (NASA Langley Research Center Hampton VA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Confer ence 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2513* 8 p 6 refs

A research data system developed for in flight measurement of direct and nearby lightning-strike characteristics is described The measurement system consists of a wide-band analog recorder which records the continuous lightning scenario and fast sample rate digital transient recorders with augmented memory capacity for increased time resolution of specific times of interest Electromagnetic sensors with bandwidths exceeding 100 MHz are used which respond to rates of change of the quantities being measured Data system immunity from electromagnetic interference is accomplished by the use of a dynamotor for power isolation shielded system enclosure and fiber optic data links (Author)

A82 13911 # **Instrumentation to determine the suitability of RNAV systems for helicopter navigation in the national airspace system /NAS/** J Gallagher and R D Till (FAA Technical Center Atlantic City NJ) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2514* 9 p 14 refs

This paper describes instrumentation developed and flight testing conducted by the Federal Aviation Administration (FAA) Technical Center to determine the suitability of RNAV systems for helicopter navigation A data collection package consisting of a militarized minicomputer interfaced to aircraft sensors and RNAV systems typically representative of LORAN C GPS Inertial Naviga tion and Omega was designed and fabricated A portable low cost position tracking system was devised for non precision approach navigation tests by Kalman filtering post flight position data derived from a pulsed radar ranging system with inertial and air data measurements resulting in improved position accuracy (Author)

A82 13913 * # **Rotor systems research aircraft /RSRA/ rotor force and moment measurement system** J S Burks (NASA Ames Research Center Moffett Field CA) *AIAA, SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2516* 12 p

The two Rotor Systems Research Aircraft (RSRA) are flight vehicles with unique measurement capabilities The primary goal of the RSRA is direct measurement of rotor forces and moments in flight This is accomplished through a rotor force and moment measurement system comprised of load cells and/or hydro pneumatic isolator units which are integral to the aircraft structure Due to structural flexibility the aircraft must undergo a physical calibration A static calibration of the first RSRA has been completed and data analysis has progressed through determination of a linear calibration algorithm Design development and operation of the RSRA rotor force and moment measurement system and the Static Calibration Facility are described and results of the calibration are presented (Author)

A82 13916 # **The Air Force Flight Test Center Utah Test and Training Range in the 1980 s** C E Adolph (USAF Flight Test Center, Edwards AFB CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2487* 9 p

The Air Force Flight Test Center (AFFTC) conducts and supports manned and unmanned aircraft flight tests development testing of parachutes operates the Edwards Flight Test Range the USAF Test Pilot School and the Utah Test and Training Range This paper summarizes the evolutionary forces in the technical and management areas which gave impetus to today s methods of operation Current capabilities and procedures are then described followed by a discussion of improvements planned to meet the demands of the mid to late 1980 s (Author)

A82 13917 # **The need for, and development of a simulation facility at the Naval Air Test Center** B L Hildreth and A C Cruce (U S Navy Naval Air Test Center Patuxent River MD) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2488* 9 p

Attention is given to the problem created by on the one hand rapidly rising test costs and on the other the increasing test requirements to satisfactorily evaluate systems of ever increasing complexity A partial solution to this problem is to raise the productivity of the testing performed in terms of quantities of data gathered per dollar or per flight hour Four benefits of a combined flight test/simulation program are cited improved safety increased productivity ability to test modern complex highly integrated systems and the capability to test system performance against simulated threat environments The requirements for a facility design based on these factors are discussed and the current progress of the Naval Air Test Center toward developing a facility to meet these requirements is covered C R

A82-13919 * # **A unique integrated flight testing facility for advanced control/display research** V M Batson J J Hatfield (NASA Langley Research Center, Hampton VA) and N E Novack (NASA Wallops Flight Center, Wallops Island VA) *AIAA SETP SFTE SAE ITEA, and IEEE Flight Testing Conference, 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2490* 11 p 13 refs

NASA is engaged in programs aimed at developing avionic concepts and systems technology for air transportation systems of the 1980 s and beyond A part of these programs is related to the development of advanced concepts and avionics technology for integrated displays and controls In support of these efforts an interactive Flight Display Research System (FDRS) has been developed as an integral part of integrated flight test facilities which have been used in evaluation studies of integrated display and control concepts in support of a VTOL Approach and Landing Technology (VALT) program and current Terminal Configured Vehicle (TCV) program A description is provided of several of the advanced integrated display and control concepts that have evolved within the VALT TCV and general aviation programs as well as the integrated flight test facilities G R

A82 13921 # **Collection and simulation of spatial infrared signatures of military jet aircraft** W D Foster and H I Register (USAF, Eglin AFB, FL) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2494* 6 p

The 3246th Test Wing at Eglin Air Force Base has developed airborne systems capable of collecting high resolution infrared data from ground and airborne targets The beam approach seeker evaluation system includes test guidance units spatial scanners television cameras with missile track points and a laser ranger Infrared target simulation is designed to reproduce the infrared spatial data collected by the high resolution instrumentation system The two approaches to this concept are the miniature filament approach and the thermochromics approach which uses VO2 S C S

A82 13922 # **Flight testing the suspended maneuvering system** R K Svec (McDonnell Douglas Corp St Louis MO) *AIAA, SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2498* 8 p

The Suspended Maneuvering System (SMS) has been developed as a rapid response rescue vehicle that expands the capabilities and versatility of today's rescue methods Suspended from a helicopter the SMS is maneuvered horizontally by an onboard operator using an advanced thrust control system This unique concept an adaptation of modern aerospace technology provides access to places considered inaccessible or hard to reach with conventional emergency equipment Combating fires in high rise buildings is one major SMS application The flight test program concentrated on tests at a simulated high rise building to develop the capability and techniques for 'docking' at windows and subsequent personnel entry and egress through the windows (Author)

A82 13924 # **Improved techniques for the calibration and measurement of in flight loads** K A Birk and R L Kuebrich (McDonnell Aircraft Co St Louis MO) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas, NV Nov 11 13 1981 AIAA Paper 81 2502* 10 p

Techniques are presented for the calibration of strain gage bridge circuits installed in the F/A 18 wings Methods are described which develop equations to solve for the traditional shear bending moment and torsional loads for a variety of flight conditions The major improvements described are the use of zone loading techniques to enhance strain gage slope determination from the calibration loads the application of a family of flight equivalent distributed loads to better assess equation accuracy and the formulation of computer aided analysis techniques which allow review of larger volume of data while requiring fewer manhours (Author)

A82-13928 # **Overview of flight and ground testing with emphasis on the wind tunnel** J D Whitefield (Sverdrup Technology Inc Tullahoma Calspan Field Services Inc Arnold Air Force Station TN) B J Griffith R W Butler (Calspan Field Services Inc Arnold Air Force Station TN) and C Bang (USAF Arnold Air Force Station TN) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2474* 11 p 32 refs

A general overview of the development of (1) aircraft and missiles (2) the wind tunnel and (3) the emerging role of computational techniques is given Special comparisons between ground test data and flight data from aircraft space vehicles and reentry vehicles are made The paper discusses some of the historical development of aircraft and ground testing with emphasis upon how computational fluid dynamic (CFD) techniques aid both the design and ground testing of flight vehicles The speed regimes covered include low speed the transonic regime supersonic and reentry speeds The methodology development made possible by the advent of CFD will be illustrated Finally likely future trends in ground test facility development full scale flight testing and CFD are discussed The future role of ground testing and CFD in the development of aircraft and missiles in the 1980 s and 1990 s is assessed (Author)

A82 13929 # **F-4 Advanced Avionics Flight Test** H A Tracy (USAF Eglin AFB FL) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2464* 6 p

Testing the integration of a new digital avionics navigation and weapon delivery system including the interface with its sensors into an aging aircraft with an analog system can be filled with problems During previous flight tests a 3/1 ratio of flown/productive flights was experienced A current productivity rate approaching 100% can be related to pre mission testing of software and real time display of test data Pre mission testing consists of loading the test software into a test simulator and performing simulated tasks to verify operation of the test software prior to loading it into an aircraft for flight Real time display of test data is accomplished by inserting a software overlay into the airborne computer which outputs data to an external instrumentation pod where the data are recorded and transmitted via microwaves to the ground control facility The displayed data include switch settings system errors ground track of the aircraft and software discretes (Author)

A82-13930 # **F/A 18 high authority/high gain digital flight control system development and flight testing** R A Burton and B T Kneeland Jr (U S Navy Naval Air Test Center Patuxent River, MD) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2465* 8 p 6 refs

The F/A 18 airplane employs a fly by wire full authority/high gain digital flight control system (FCS) which at times can completely dominate aircraft response to pilot inputs resulting in higher order system responses that are a new and significant challenge for the flight test engineer to analyze This paper overviews the development of the F/A 18 digital FCS detailing changes to the programmable read only memory (PROM) flight control laws to correct flying qualities problems In addition a summary of the advanced stability and control test techniques and data analysis

procedures used are presented and it is demonstrated how these techniques can quantify complex changes in flight control laws These techniques consist of a maximum likelihood parameter identification program used to perform an equivalent system analysis Data are presented which demonstrate the success the airframe contractor has had in reducing overall system equivalent time delays (Author)

A82 13931 * # **The development and flight test evaluation of an integrated propulsion control system for the HiMAT research airplane** J L Baer Riedhart (NASA Flight Research Center Edwards AFB CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2467* 10 p 8 refs

The Highly Maneuverable Aircraft Technology airplane is a 44 scale version of an advanced fighter design It is remotely piloted from a ground cockpit and is powered by a J85-GE 21 turbojet engine The engine is electronically controlled by a digital computer onboard the airplane to operate at selected engine operation modes The HiMAT design and development philosophy emphasized high risk low cost and minimum testing and also required that no single failure would cause loss of the vehicle This philosophy generated unique requirements for design computer simulation methods specialized test techniques and support systems which are discussed in this paper (Author)

A82 13936 # **Comparison of low speed handling qualities in ground based and in flight simulator tests** M F C van Gool (Nationaal Lucht en Ruimtevaarlaboratorium Amsterdam Nether lands) and N C Weingarten (Calspan Advanced Technology Center Buffalo NY) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2478* 9 p 9 refs Research supported by the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart and Rijkslucht vaartdienst Contract No F33615-79-C 3618

Approaches and landings have been carried out using the Total In Flight Simulator (TIFS) to validate results of experiments on a ground based simulator in which handling qualities of transport aircraft equipped with advanced flight control systems were the subject of investigation The configurations featured rate command/attitude hold in the pitch and roll axes Variation of equivalent short period frequency pitch rate overshoot value of the normal acceleration sensitivity parameter direct lift control roll damping and roll time delay was studied The results indicate that the ground based investigation predicted the outcome of the in flight experiments very well with the exception of the case with direct lift control in which objectionable normal accelerations were felt in flight that were not noticed during the ground based simulation (Author)

A82 13938 * # **Powered lift STOL aircraft shipboard operations A comparison of simulation, land based and sea trial results for the QSRA** V C Stevens D W Riddle J L Martin and R C Innis (NASA Ames Research Center Moffett Field CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2480* 16 p 10 refs

A moving base carrier landing flight simulation using NASA's Quiet Short Haul Research Aircraft (QSRA) was conducted during the design and fabrication of the QSRA After completing its initial flight testing the QSRA flew simulated carrier landings on land followed by actual carrier landings at sea This paper compares the simulated flight characteristics used in the flight simulation (using an aircraft math model based on wind tunnel data) with the aircraft flight characteristics obtained from flight test data This paper also compares the results of the QSRA flight simulation carrier landings the land based simulated carrier landings and the actual carrier landings (Author)

A82 13939 * # **A large-scale investigation of engine influence on inlet performance at angle-of attack** B K Hodder B W Farquhar (Boeing Commercial Airlane Co Seattle WA) and M R Dudley (NASA Ames Research Center Moffett Field CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2481* 13 p 6 refs

A low speed wind tunnel test was conducted in the NASA/Ames 40 x 80 foot wind tunnel to investigate the effect of engine/inlet flowfield interaction on inlet performance near flow separation The effect of engine/inlet flowfield interaction was determined by comparing the performance of a large scale subsonic inlet (CR = 1 26) close coupled and remote coupled to a TF 34 turbofan engine The remote coupled inlet configuration removes the influence of the engine on the inlet flowfield and further typifies conventional small scale inlet test techniques which generally provide no simulation of turbomachinery effects Test results indicated that engine interaction allows the inlet to operate with lower distortion levels at and beyond the separation angle of attack attained without engine interaction (Author)

A82 13940 # **Naval Weapons Center Test and evaluation in the 1980 s** R V Boyd (U S Naval Weapons Center China Lake CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2485* 10 p

The Naval Weapons Center (NWC) at China Lake CA has test and evaluation missions that include strike weapons for land and sea targets air to air systems antiradiation missiles and antiship missile defense systems NWC facilities are outlined, noting current programs that comprise new warheads propulsion systems guidance and control units and missiles with extended range higher speeds and multiple target capability Modernization efforts comprise an on axis data system a real time radar/optics system for precision space position velocity and acceleration measurements a metric video TV system a telemetry data acquisition system, upgraded range communication timing and control systems, and airspace surveillance system enhancement A range control center centralized and technically current will provide direct support for weapons testing provide test data packaging and be able to support several simultaneous tests D H K

A82 13941 # **Two at a time Flight test plans for the new Boeing airliners** B S Wygle (Boeing Co Seattle WA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2378* 5 p

Contracts regarding the sale of a new 200-passenger medium range airliner and a 170 passenger short to med um range airliner led to a situation in which the first airliner of one type is to be delivered in January 1983 about five months after delivery of the first aircraft of the other type The flight test programs will substantially overlap during 1982 and create an unprecedented work level during that year To manage the work load the company has developed a flight test computer system and a training program for engineers Remote test sites have been selected to provide good weather conditions and low traffic levels G R

A82 13942 # **Operational evaluation of the new generation of jet transport aircraft** C R Foster (FAA Seattle WA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981, AIAA Paper 81 2377* 12 p

Within the Lead Region for Transport Aircraft the FAA is upgrading its capability for operational evaluation of the new generation of transport aircraft The responsibilities of the Certification and Flight Standards Divisions are described with emphasis on the role of the FAA's Aircraft Evaluation Groups (AEG) The AEG's ensure that the necessary FAR 121 91 61 and other operating rules can be met by new aircraft at the time the aircraft enter line service The AEG's also address aircraft operations policies described in FAA advisory material or ICAO standards for airport facility and ATC compatibility Specific topics covered include the type rating training and maintenance programs minimum equipment lists crew workload and crew complement evaluation and continued operational support after entry into service (Author)

A82 13944 # **Flight test concept evolution** L G Van Pelt (USAF Eglin AFB FL) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2375* 11 p

A chronicle of progress in flight test philosophy is very revealing Ever increasing emphasis has been placed upon the need

for flight test to be thorough and still meet the need for timely introduction of effective new aircraft into the operational inventory Major flight test concepts (Phase Testing Category Testing and Development Test and Evaluation/Operational Test and Evaluation) have been influenced by nuances such as concurrency fly before buy total package procurement prototyping competitive fly off etc An understanding of these experiences and lessons learned will help in today s preparation of effective and efficient test programs (Author)

A82 13945 # **Electro optical vector scoring system** R Rackauskas (U S Navy Pacific Missile Test Center Point Mugu CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2373* 6 p

An electrooptical vector scoring system has been developed for miss distance scoring in fleet training exercises and for the testing and evaluation of weapon systems The system utilizes solid state light emitting GaAs diodes which emit extremely short pulses of infrared radiation at 0 9 micron wavelength The raw data obtained (range azimuth angle time) can be used to determine the relative velocity vector A line drawn perpendicular to the relative velocity vector that passes through the center of the vector scoring system determines the miss distance Score data is telemetered to a ground computer that computes velocity vector miss distance and the missile s attitude angle relative to the target S C S

A82 13946 * # **The development and use of a computer interactive data acquisition and display system in a flight environment** G A Bever (NASA Flight Research Center Edwards CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11-13 1981 AIAA Paper 81 2371* 16 p 6 refs

The flight test data requirements at the NASA Dryden Flight Research Center increased in complexity and more advanced instrumentation became necessary to accomplish mission goals This paper describes the way in which an airborne computer was used to perform real time calculations on critical flight test parameters during a flight test on a winglet-equipped KC 135A aircraft With the computer an airborne flight test engineer can select any sensor for airborne display in several formats including engineering units The computer is able to not only calculate values derived from the sensor outputs but also to interact with the data acquisition system It can change the data cycle format and data rate and even insert the derived values into the pulse code modulation (PCM) bit stream for recording (Author)

A82 13947 # **Automatic digital gain ranging** E G Hanson (Grumman Aerospace Corp Bethpage NY) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2370* 5 p 13 refs

A logic circuit has been patented that automatically up scales and down scales digitized voice or data transmissions in response to variations in input amplitude Although it was originally developed to compress flight test telemetry data the circuit can also be used advantageously in companding (data or voice compression and expansion) applications that are widely encountered in the communi cations industry In this specialized application the circuit can be made to yield a close approximation to the 'mu law' characteristic which is an accepted standard in this country Complementary logic circuitry will also be described for expanding compressed digital transmissions to their original linear digital form (Author)

A82 13948 # **The Advanced Range Instrumentation Aircraft improvement and modernization program** J S Nash (USAF Systems Engineering Branch Wright Patterson AFB OH) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2368* 4 p

The Advanced Range Instrumentation Aircraft (ARIA) seven EC 135 aircraft configured for reception recording and real time relay of telemetry data are being retrofitted with new instrumenta tion to meet user s requirements for mobile telemetry collection and retransmission through the turn of the century Two sets of ARIA Prime Mission Electronic Equipment have been transferred to C 135B aircraft with TF 33 fan engines Additional conversions will utilize Boeing 707 320Cs Instrumentation changes include new recorders antennas antenna control systems feeds tracking systems and telemetry receivers (Author)

A82 13949 # **Lockheed Airborne Data System Distributed microcomputers provide on board real time analysis** J A Tabb (Lockheed Georgia Co Marietta GA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2367* 9 p

This paper describes the more innovative features of the Lockheed Airborne Data System (LADS) and provides some insight into the high performance and cost effectiveness realizable by use of multiple processors in real time data systems LADS uses multi processors in a highly distributed configuration to control verify process analyze and display data in real time on board the test aircraft The approach is to use remotely located signal conditioner/multiplexer modules controlled in groups by distributed microcomputers which preprocess all incoming data These micro computers are synchronously controlled by a central data station which provides digital analog, video and graphics displays of calibrated (engineering units) data in real time to on board test personnel The airborne system includes an integral analysis com puter station with graphics and hard copy for real time analysis (Author)

A82 13955 # **F/A 18 Flight Test program overview 1 September 1981** E R Shields (McDonnell Aircraft Co St Louis MO) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2351* 9 p

This report presents a F/A 18 Flight Test program overview including a discussion of pre flight planning objectives The flight envelope expansion program proceeded subsequent to first flight accumulating in excess of 2 600 flight hours in 24 months Initial shipboard trials were completed successfully aboard the USS America Navy/Marine pilot participation provided early customer inputs to the flight development process Currently the flight test program is nearing completion Service Acceptance Trials and Navy Operational Evaluation are to be conducted during 1982 (Author)

A82 13956 # **Navstar Global Positioning System flight test program overview** A J MacMillan (Aerospace Corp El Segundo CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2350* 9 p Contract No F04701 80 C 0081

The Navstar Global Positioning System (GPS) which is now in the full scale engineering development phase is discussed An overview of the program including brief descriptions of the purpose of the program and of each of the three segments (space control and user equipment) is given A description is also given of the test range at Yuma Proving Ground Arizona, including the real time laser tracking system The development test and evaluation phase extending from 1977 to 1979 is described and some of the important results are presented C R

A82 13962 # **Development of a lifting parachute to provide self dispersing capability for an Avco designed tactical munition** R J Kingsley (Avco Corp , Avco Systems Div Wilmington, MA) and J D Reuter (Pioneer Parachute Co Inc , Manchester CT) *American Institute of Aeronautics and Astronautics Aerodynamic Decelerator and Balloon Technology Conference 7th, San Diego, CA Oct 21 23 1981 Paper 81 1928* 9 p

This paper describes a program of analysis and test to develop a lifting parachute to provide ground dispersion for an assemblage of tactical munitions when air launched at low altitudes A parachute lift to-drag ratio of 0 3 to 0 4 will provide acceptable pattern length and width Experiments were begun with parachutes of both ribbon and cruciform designs but unusual packaging restrictions eliminated the ribbon design Full scale parachutes were first evaluated for low speed lift performance and then tested in a transonic wind tunnel Free flight tests were performed with a stack of four munitions using a special rail launched booster rocket facility The sequencing, or spacing of each munition in a stack is a critical factor

in achieving optimum ground pattern and avoiding collision (Author)

A82-13963 # **Theoretical analysis of wake induced parachute collapse** H R Spahr and D F Wolf (Sandia National Laboratory Albuquerque NM) *American Institute of Aeronautics and Astronautics Aerodynamic Decelerator and Balloon Technology Conference 7th, San Diego CA, Oct 21 23 1981, Paper 81 1922* 8 p 16 refs Research supported by the U S Department of Energy

During recent drop tests of a prototype weapon system the parachute collapsed soon after it became fully inflated The magnitude and duration of the collapses were severe enough to degrade parachute performance drastically A computer assisted analysis is presented which models parachute inflation forebody and parachute wake generation and interaction between the wake and the inflating or collapsing parachute Comparison of the analysis results with full scale drop test results shows good agreement for two parachute sizes both parachutes were tested with and without permanent reefing Computer generated graphics (black and white drawings color slides and color movies) show the forebody and inflating parachute the wake and the wake and parachute interaction (Author)

A82 13966 # **Escape systems decelerator technology** D N DeSimone (U S Naval Material Command Naval Air Development Center Warminster PA) *American Institute of Aeronautics and Astronautics Aerodynamic Decelerator and Balloon Technology Conference 7th, San Diego CA Oct 21 23 1981 Paper 81 1913* 4 p

The development of escape system technology is considered taking into account initial ejection seat concepts during World War II safe parachute operation following escape from the aircraft fatality rates among ejectees and major modification programs during the mid to late 1960 s Advances in military parachute technology are considered and technological problems associated with drogue stabilization parachutes are examined Attention is given to characteristics which are commonly encountered with today s escape system decelerator There is found to be a need for advancements in the state of the art in escape system decelerator technology C R

A82 13968 * # **Modeling procedures for handling qualities evaluation of flexible aircraft** K S Govindaraj B J Eulrich and C R Chalk (Calspan Advanced Technology Center Buffalo NY) *Institute of Electrical and Electronics Engineers Annual Allerton Conference on Communication Control and Computing 19th Monticello IL Sept 30 Oct 2 1981 Paper* 11 p NASA supported research Contract No F33615 79 C 3618

This paper presents simplified modeling procedures to evaluate the impact of flexible modes and the unsteady aerodynamic effects on the handling qualities of Supersonic Cruise Aircraft (SCR) The modeling procedures involve obtaining reduced order transfer function models of SCR vehicles including the important flexible mode responses and unsteady aerodynamic effects and conversion of the transfer function models to time domain equations for use in simulations The use of the modeling procedures is illustrated by a simple example (Author)

A82 13969 * # **Aeroelasticity matters Some reflections on two decades of testing in the NASA Langley Transonic Dynamics Tunnel** W H Reed III (NASA Langley Research Center Loads and Aeroelasticity Div Hampton VA) *Deutsche Gesellschaft fur Luft und Raumfahrt and Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt International Symposium on Aeroelasticity Nurnberg West Germany Oct 5 7 1981 Paper* 17 p 47 refs

In 1955 work was started on the conversion of a subsonic wind tunnel to a 16 foot transonic tunnel with Freon 12 or air as the test medium The new facility designated the Transonic Dynamics Tunnel (TDT) became fully operational in 1960 A description is presented of aeroelastic testing and research performed in the TDT since 1960 It is pointed out that wind tunnel tests of aeroelastic models require specialized experimental techniques seldom found in other types of wind tunnel studies Attention is given to model mount systems launch vehicle models aircraft models, aircraft buffet gust response stability derivative measurements and subcritical testing techniques Aspects of vehicle development testing are considered along with aeroelastic fixes aeroelastic surprises approaches for controlling aeroelastic effects and unsteady pressure measurements G R

A82 13971 * # **The development of cryogenic wind tunnels and their application to maneuvering aircraft technology** E C Polhamus and R P Boyden (NASA Langley Research Center Hampton VA) *NATO AGARD Symposium on Combat Aircraft Maneuverability Florence Italy Oct 5 8 1981 Paper* 13 p 20 refs

Cryogenic wind tunnels are considered as a means of studying high Reynolds number (Re) complicated flows encountered by high maneuvering lift and high angles of attack characteristic of modern fighter aircraft Large decreases in the viscous force while the inertial force remains constant are provided by the use of cryogenic facilities A 2 5 m square tunnel is nearing completion at the National Transonic Facility (NTF) and will be driven by synchronous motors having a total power of 120 000 hp The tunnel using N2 as the cryogenic fluid will allow large Re sweeps at constant dynamic pressure and dynamic pressure and aeroelastic sweeps at constant Re full altitude (air density) and acceleration force simulation will also be possible Advances in model and strain gage balance technologies for use at the NTF are outlined and experiments with buffet are described M S K

A82 13972 * # **The integration of control and display concepts for improved pilot situational awareness** L H Person Jr and G G Steinmetz (NASA Langley Research Center Hampton VA) *Flight Safety Foundation International Air Safety Seminar 34th Acapulco Mexico Nov 9 12 1981 Paper* 16 p

Consideration is given to a part of the Langley Terminal Configured Vehicle program in which the pilot is retained as an active segment of an integrated system The pilot is active in the outer control loop and controls the orientation of the aircraft velocity The pilot thus has a task but a low workload Attention is also given to first and second generation primary flight display for horizontal and vertical situation awareness S C S

A82 13973 * # **Jet V/STOL wind tunnel simulation and groundplane effects** R J Margason (NASA Langley Research Center Subsonic Aerodynamics Branch Hampton VA) *NATO AGARD Symposium on Fluid Dynamics of Jets with Applications to V/STOL Lisbon Portugal Nov 2 5 1981 Paper* 22 p 55 refs

Low speed wind tunnel testing of V/STOL aircraft concepts to determine the aerodynamic propulsion interaction effects during the transition between hover and wingborne flight is a necessary step in the development cycle of this type of aircraft Powered models are normally used to determine the aerodynamic performance characteristics This paper examines some of the pretest preparation necessary to define the objectives of an appropriate investigation Several factors which influence the selection of the model concept and the engine simulator are discussed In addition some of the test techniques important for this class of aircraft model are examined Finally the paper reviews some of the wind tunnel wall effects important to this type of aircraft testing with special emphasis on groundplane effects (Author)

A82 13974 * # **Progress in aeronautical research and technology applicable to civil air transports** R E Bower (NASA Langley Research Center Hampton VA) *International Meeting on Transportation Research State of the Art Perspectives and International Cooperation Amalfy Italy Nov 11 14 1981 Paper* 51 p

Recent progress in the aeronautical research and technology program being conducted by the United States National Aeronautics and Space Administration is discussed Emphasis is on computational capability new testing facilities drag reduction turbofan and turboprop propulsion noise composite materials active controls integrated avionics cockpit displays flight management and operating problems It is shown that this technology is significantly impacting the efficiency of the new civil air transports The excitement of emerging research promises even greater benefits to future aircraft developments (Author)

A82 13975 # **Flight vibration optimization via conformal mapping** F D Bartlett Jr (U S Army Structures Laboratory Hampton VA) *American Helicopter Society Northeast Region National Specialists Meeting on Helicopter Vibration Technology for Jet Smooth Ride Hartford CT Nov 2 4 1981 Paper* 11 p 7 refs

An analytical approach based on the principle of conformal transformations is presented for evaluating the effects of structural dynamic changes on flight vibrations Structural dynamic changes are characterized by discrete and multidimensional impedance adjustments Discrete impedance changes such as point mass colinear stiffness and dynamic absorbers are emphasized to illustrate the practical aspects of the approach for flight vibration optimization Conformal mapping through inspections of complex plane response circles offers the capability for rapid evaluation of discrete impedance change effects on flight vibrations The operational equations require only baseline vibration data and impedance change dynamics Specific criteria for reducing vibrations are established using the response circle equations In addition the required impedance change to achieve minimum or zero vibration is uniquely defined Flight vibration optimization is illustrated using a remote absorber in conjunction with AH 1G helicopter ground and flight vibration measurements Vibration reduction and absorber performance are assessed at several flight conditions and airframe stations (Author)

A82 13990 # **A set of finite elements developed for the dynamic computation of composite helicopter blades** L Simon (Societe Alkan Valenton Val de Marne ONERA Chatillon sous Bagneux Hauts de Seine France) *(Institution of Mechanical Engineers National Engineering Laboratory and Paisley College of Technology International Conference on Composite Structures Paisley Scotland Sept 16 18 1981) ONERA TP* no 1981 87 1981 16 p 10 refs

The paper proposes the creation of a set of finite elements for the computation of the eigenmodes of a helicopter rotor or airscrew blade made of composite materials in rotation or at rest Isoparametric thick shell type elements are formulated to obtain degrees of freedom on the blade airfoil skeleton The stiffness and consistent mass elements are presented to allow the computation of the eigenmodes of the clamped structure at rest and the convenience of discretizing the terms of the variational formulation is demonstrated Centrifugal effects giving a centrifugal stiffness element are used to determine the quasi static equilibrium position which can then determine the prestress due to spinning effects Finally the gyroscopic eigenvalue problem is developed and numerical results are compared with experimental results for a tilt rotor blade aeroelastic model D L G

A82 13992 # **Application of the ONERA dynamic stall model to a helicopter blade in forward flight** C T Tran (ONERA Chatillon sous Bagneux Hauts de Seine France) and D Falchero (Societe Nationale Industrielle Aerospatiale Marignane Bouches du Rhone France) *(Deutsche Gesellschaft fur Luft und Raumfahrt European Rotorcraft and Powered Lift Aircraft Forum 7th Garmisch Partenkirchen West Germany Sept 8 11 1981) ONERA TP* no 1981 89, 1981 26 p 12 refs

A single blade analysis for a helicopter rotor in hover and in forward flight is developed, which applies the unsteady aerodynamics of the ONERA two dimensional dynamic stall model The stability of the aeroelastic system is studied by means of the Floquet theory and it is shown that the subharmonic oscillation and almost periodic oscillation of the Floquet modes can readily occur Periodic responses for the quasi steady and unsteady calculations are compared and it is found that while the blade normal lift force distribution is insensitive to unsteady effects the blade aerodynamic pitching moment and the torsional response are subjected to more influence of the unsteady aerodynamic pitching moment damping and time delay effects It is concluded that the introduction of the blade flap and lead leg elastic deformations should present no difficulty in principle by a modal superposition of the blade s normal modes D L G

A82 13993 # **Development of an MLS lateral autoland system with automatic path definition** A A Lambregts (Boeing Commercial Airplane Co Seattle WA) *American Institute of Aeronautics and Astronautics Guidance and Control Conference Albuquerque NM Aug 19 21 1981 Paper 81 1751* 8 p 5 refs

The new Microwave Landing System will provide extended aircraft guidance capability in the terminal area To utilize this capability effectively requires that the approach path be defined This paper describes the development and simulator evaluation of an MLS lateral autoland control algorithm using automatic path definition The algorithm connects the initial approach path to the extended runway centerline using straight and constant radius turn segments The path is executed by a linear track and a novel circular turn control law to capture a straight track using MLS azimuth and DME signals The algorithm eliminates maneuver transients when switching to MLS guidance and avoids external path definition inputs (Author)

A82 14042 # **Aircraft absorbers Promise and practice** A O Andersson (Boeing Commercial Airplane Co Seattle WA) *Acoustical Society of America Meeting 101st Ottawa Canada May 18 22 1981 Paper* 21 p

Attention is given to the application of sound absorbers to aircraft engine ducts Fan duct application is discussed with reference to the frequency spectrum of fan noise the wave number spectrum of fan noise and both local and extended reactions to lining types The design of duct linings is examined noting a number of analysis techniques for non uniform ducts and linings The impedence meter is considered for non destructive testing of curved lining panels and possibilities for mode measurements for lining design are reviewed S C S

A82 14043 **Impedance modeling of acoustic absorbing materials for aircraft engine applications** L W Dean III (United Technologies Corp Commercial Products Div East Hartford CT) and W P Patrick (United Technologies Research Center East Hartford CT) *Acoustical Society of America Meeting 101st Ottawa Canada May 18 22 1981 Paper* 51 p 65 refs

A review of conditions under which impedance is a useful concept in solving the problem of wave propagation in a duct with flow is presented with illustrative examples Organized procedures for modeling single and multiple degree of freedom configurations both of the lumped and distributed parameter type are discussed and data and model predictions are compared for some specific configurations Assumptions usually made in the modeling process are pointed out and the effect of the assumptions particularly on the comparisons with data are evaluated Improved impedance models developed more recently are reviewed and compared with previous models and with impedance tube data Included in the discussion are models for bulk absorber materials compatible with aircraft engine environments (Author)

A82 14354 **Fighters Improving the breed** G Warwick *Flight International* vol 120 Nov 7 1981 p 1369 1370 1374 1375

Performance capability gains are projected in light of structural and weapon system modifications to the F 15 and F 16 aircraft The conversion of the F 16 to the F 16E variant entails the addition of two fuselage plugs that lengthen the fuselage by 56 in and the bolting on of a double delta wing having 120% greater area than the present one Together these modifications increase internal fuel capacity by 82% representing 124% greater range for the same payload Attention is also given the staged development and retrofit of day/night all weather air defense and ground attack F 16 electronics The modifications contemplated for the F 15E two seat variant include synthetic aperture radar (SAR) and a rear cockpit equipped with CRT displays for radar forward looking infrared (FLIR) threat warning and a computer generated tactical map O C

A82 14363 **Trim tab excitation system for the BAe 146** P Lawson (Cranfield Institute of Technology Cranfield Beds England) *Aircraft Engineering* vol 53 Oct 1981, p 12

An account is given of the design of an aileron and elevator trim tab controlled excitation system which would assist in BAe 146 control surface flight clearance trials For the flutter trials to be valid it was necessary to devise an excitation system which would fit into wing and tailplane structures without their modification In

order to provide an effective fail safe system against electrical or hydraulic failure the trim tab centralizing mechanism exceeds the actuator stall load by more than 2 1 which in the case of the elevator requires about 5 000 lbs of axial thrust The mechanism employed comprises a spring-loaded toggle linkage operating a wedge into the side of the main actuator piston Bench tests show an adequate system response over the 1 60 Hz frequency range required O C

A82 14364 The protection of gas turbine blades A platinum aluminide diffusion coating R G Wing (Rolls Royce Ltd Leavesden Herts England) and I R McGill *Aircraft Engineering* vol 53 Oct 1981, p 15 21 17 refs

The combination of high turbine operating temperatures and the presence of ingested sulphate and chloride salts in the marine environments in which ships hovercraft and helicopters operate can lead to the costly hot corrosion of turbine blades A discussion is presented of the use of platinum aluminide coatings to protect super alloy turbine blades from both oxidation and hot corrosion with greater effectiveness than nickel aluminide diffusion coatings Because of the problems of poor adherence, high porosity and hardness associated with the use of electroplating in the application of the initial platinum coating to nickel based super alloy blades a fused salt platinum deposition process has been developed The aluminizing of this base layer is conducted at temperatures below 800 C yielding a 50 micron platinum aluminide layer of which only the outer two microns are pure with greater depths containing a beta nickel aluminum intermetallic Burner rig test results in which contaminants representative of marine environment conditions are reported for the cases of two coatings produced by the new deposition method JML 1 and 2 O C

A82 14365 Attack on superalloys by chemical and electrolytic processes H Simon and M Thoma *Aircraft Engineering* vol 53 Oct 1981, p 22 25

In the course of such turbine aircraft engine production and overhaul surface treatment processes as electrolytic degreasing chemical and electrochemical etching chemical descaling and chemical stripping of thermally sprayed coatings the precipitation hardened nickel and cobalt base alloys of the highest temperature turbine elements are subjected to corrosion This effect is due to the carbide nitride and carbonitride intermetallics formed by alloying elements added for precipitation hardening, which appear as inclusions of various shapes and sizes within the grain or at the grain boundaries It is shown that these intermetallics present as separate phases, can be dissolved out by oxidative attack Backscattered electron and X ray analyses of seven nickel and cobalt base materials lead to the conclusion that certain processes or process steps cannot be employed in production and overhaul and alternative processing methods are suggested O C

A82 14376 # Status and tracking system for flight test data products R Large W May and D O Keefe (USAF Flight Test Center, Edwards AFB CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2395* 13 p

A flight test data product status and tracking (SANDT) system has been developed and used by the Air Force Flight Test Center Initially used in support of the Air Launched Cruise Missile Program the SANDT has recently been applied to F 15 testing The SANDT makes use of System 2000 Data Base Software on the Center s CDC CYBER 74 scientific computer The paper will discuss the requirements design alternatives resource use, and operating experience to date Results include improved data support planning flexibility in supporting dissimilar flight test program and integration of data processing with status reporting (Author)

A82 14377 # An advanced facility for processing aircraft dynamic test data D J Stouder (Douglas Aircraft Co Long Beach CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2398* 10 p

Capabilities of the Acoustics and Vibration Data Center (AVDC) are described using examples from various flight and laboratory tests related to commercial and military jet transports Features such as the one third octave band spectrum analysis and the narrow band spectrum analysis which were developed to derive noise intensity and annoyance parameters are discussed The paired signal analysis for studying input output problems and audio presentation are also described In addition future developments are summarized, including the integration of the AVDC with the main flight test data processing facility D L G

A82 14379 * # Experience with flight test trajectory guidance M R Swann E L Duke E K Enevoldson and T D Wolf (NASA, Flight Research Center, Edwards CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st, Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2504* 8 p 5 refs

A system that provides the test pilot with flight test trajectory guidance is presently evolving at the NASA Dryden Flight Research Facility In use this system has resulted in discernible improvements in the ease and accuracy with which pilots have approached and maintained the desired flight test conditions or trajectories This paper describes the use of the guidance system in several past flight programs at Dryden including the F 111 TACT program the F 15 airframe/propulsion system interaction program, the F 15 cone transition and boundary layer experiments, and the Space Shuttle tiles flight test program (Author)

A82 14380 # Pave Mover Flight Test Program D E Holberg and J F Grabowsky (Hughes Aircraft Co Los Angeles CA) *AIAA, SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13, 1981 AIAA Paper 81 2492* 11 p USAF DARPA sponsored research

Pave Mover is an Advanced Development Model Program performed by Hughes Aircraft Company and sponsored by the Rome Air Development Center and DARPA It is currently under test at White Sands Missile Range New Mexico The system consists of an F 111E aircraft carrying a long range MTI/SAR radar and a ground based data processing and control system connected by a two way Sperry data link Pave Mover is the radar portion of the DARPA conceived Assault Breaker concept demonstration designed to counter a massive attack of tank forces by radar updated surface to surface missiles equipped with anti tank submunitions During the demonstration it is also intended to track and guide air to surface missiles and manned attack aircraft After a brief system description the paper discusses flight test aspects such as aircraft modification, the removable radar/pallet design simulated targets remotely controlled tank targets missile simulation using an F 4 aircraft the accuracy reference instrumentation and various software simulators used in preparation for the tests (Author)

A82 14381 * # In flight deflection measurement of the HiMAT aeroelastically tailored wing V M DeAngelis (NASA Ames Research Center Edwards CA) *AIAA SETP SFTE, SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2450* 11 p

An electro optical flight deflection measurement system was developed for NASA for use on the highly maneuverable aircraft technology (HiMAT) remotely piloted research vehicle (RPRV) to provide a means of evaluating the performance of the HiMAT s aeroelastically tailored composite wing and canard A description of the flight deflection measurement system is presented from a user's viewpoint and includes the general method of operation system capabilities and limitations method of installation on the HiMAT vehicle and calibration of targets Also included is a general description of the HiMAT RPRV and its design goals Preliminary flight deflection and bending moment data were obtained at Mach 0 8 and were extrapolated to the Mach 0 9 maneuver design condition for comparison to NASTRAN predictions and ground loads test results The preliminary flight test results tended to agree with the results obtained from the static ground loads tests that is that the NASTRAN model overpredicted the streamwise twist of the composite outer wing panel (Author)

A82 14382 * # A review of flight to-wind tunnel drag correlation E J Saltzman and T G Ayers (NASA Flight Research Center, Edwards CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2475* 19 p 46 refs

Comparisons are made of wind-tunnel model and flight drag

data for various configurations representing aircraft from the mid 1940s to the 1970s Discrepancies between model and flight data such as Reynolds number effects wall interference, and aeroelastic problems are discussed String support effects and the inability of models to simulate surface deflections for longitudinal trim are also studied A wind tunnel to flight correlation of turbulent friction drag confirms the incompressible Karman Schoenherr varia tion of turbulent skin friction with Reynolds number and the T method for accounting compressibility effects NASA tested 10 deg cone research indicates that model tests which are affected by tunnel noise may require the lower disturbance level environment available in flight and it is concluded that new cryogenic facilities will improve the fidelity of model simulations of full scale flight flow phenomena D L G

A82 14383 * # **Techniques for modifying airfoils and fairings on aircraft using foam and fiberglass** M B Meyer (NASA Flight Research Center Edwards, CA) and F Jiran (Fred Jiran Glider Repairs, Mojave, CA) *AIAA SETP, SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2445* 15 p 5 refs

The concept of using foam and fiberglass reinforced plastic to modify airfoils and fairings was applied successfully to high speed aircraft at NASA Dryden Flight Research Center An on aircraft installation method was used to modify an F 15 wing glove and wing leading edge and an F 104 flap trailing edge in support of the Shuttle tile airload tests A combination of methods, both an on aircraft installation and an off aircraft fabrication for installation on the aircraft was used to modify a section of an F 111 supercritical wing with a natural laminar flow airfoil Techniques methods, problem areas and recommendations are presented which indicate that using foam and fiberglass to modify airfoils and fairings on high speed aircraft is a viable means of quickly developing airfoils and fairings with desired aerodynamic characteristics with little risk to the parent or carrier aircraft (Author)

A82 14384 # **KC-10, flight test program management The contractor's viewpoint** J L Cook (Douglas Aircraft Co Long Beach CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2380* 4 p

The management of a flight test program for the KC 10 aerial refueling tanker aircraft which included elements of development FAA certification and Air Force qualification and operational testing is described In addition to the manufacturer and the FAA the participants included the Joint AFLC/AFCS Program Office (JPO), the Air Force Primary Test Organization and the Air Force Test and Evaluation Center The flight test program involved not only tanker and receiver aircraft qualifications and operational evaluations but also air crew training ground crew training tech order validation, maintainability demonstrations human factors tests support equipment compatibility validations cargo loading demonstrations and acceptance test procedure validations It was found that a division of authority between the Air Force and the FAA was highly effective and that parallel rather than series development testing is essential to efficient test programs O C

A82 14385 # **62% manned aircraft demonstrator Next generation trainer** W H Shawler (Fairchild Republic Co Farming dale, NY) *AIAA SETP, SFTE SAE 'TEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2519* 8 p

A manned 62% scale aircraft demonstrator designed for the Air Force s next generation trainer program is reported Areas investi gated include basic handling qualities hinge moments on the flight control surfaces vertical and horizontal tail loads and spin charac teristics Results of the program are compared with wind tunnel results and scaling effects and show good agreement with the previous data for features such as flap lift increment aileron and rudder effectiveness and the maximum lift coefficient It is concluded that the 62% scale flight tests are accurate and the concept can be used for new programs such as the NGT at a greatly reduced cost D L G

A82 14386 # **Hover tests of the XV 15 Tilt Rotor Research Aircraft.** M D Maisel (U S Army Research and Technology Laboratories Moffett Field CA) and D J Harris (U S Navy Naval Air Test Center Patuxent River MD) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13, 1981 AIAA Paper 81 2501* 13 p 5 refs

A series of tests was conducted to investigate the hovering characteristics of the XV 15 Tilt Rotor Research Aircraft Various wheel heights were flown to examine the effects of ground proximity In addition to free hover the aircraft was operated on a tie down facility that provided a 1 8 m (6 ft) wheel height condition Data were obtained for hover performance both in and out of ground effect downwash phenomena handling characteristics as a function of hover height and acoustics around the hovering aircraft The results show that the XV 15 is efficient in hover and that increased control activity is required as the aircraft approaches the ground Downwash velocities are moderate at the sides of the aircraft and relatively high fore and aft The acoustics evaluation revealed moderate noise levels with an acceptable sound quality (Author)

A82 14387 # **Testing capabilities of the 3246th Test Wing** D H Williams Jr (USAF Eglin AFB FL) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2484* 7 p

The capabilities of the 3246th Test Wing at Eglin Air Force Base are reviewed and developmental non nuclear air armament systems and components are evaluated The Wing s geographic location with respect to major population centers current testing capabilities existing instrumentation facilities and plans for expanding the air to surface air to air and electromagnetic capabilities are dis cussed Typical missions using the multiobject tracking ranging and control system are presented and the seeker evaluation test system and the preflight integration of munitions and electronics systems are reported Other future programs are discussed which include increasingly sophisticated all weather weapons with significantly improved multiple kill per pass hit probabilities D L G

A82-14389 # **Integrated flight testing based on nonlinear system identification data processing techniques** J H Vincent and S N Franklin (Systems Control Technology Inc Palo Alto CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Confer ence 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2449* 11 p 7 refs Contract No N00014 78 C 0641

The results presented in this paper demonstrate the operational status of nonlinear system identification data processing techniques Aerodynamic installed thrust and flight test instrumentation cali bration models are identified for the F 4S from six different flight conditions which encompass a large range in angle of attack sideslip airspeed control inputs and body rotation rates The capability for identifying nonlinear aerodynamic models in a format compatible with preflight predictions is demonstrated A methodology for determining the accuracy of the parameters estimates is presented (Author)

A82 14390 * # **AD 1 oblique wing aircraft program** T C McMurtry A G Sim and W H Andrews (NASA Flight Research Center Edwards CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81-2354* 7 p

A NASA program for evaluation of the handling and flying characteristics of the AD 1 oblique wing aircraft is discussed The vehicle was flown to compare wind tunnel predictions with aero dynamic data explore the control system requirements and obtain a preliminary assessment of the aeroelastic effects The fiberglass sandwich skin aircraft is designed for 8 g positive and 4 g negative loading at 175 knots while the wing pivot can withstand 25 g loading Flight monitoring was accomplished with a 41 channel pulse code modulation system for telemetry and by averaging of pilot ratings Maneuvering tests are outlined noting that pilot ratings indicated acceptable handling at up to 50 deg sweep It is concluded that acceptable flying qualities can be achieved with a 60 deg sweep and that aeroelastic tailoring can be used to satisfy cruise design technology M S K

A82 14392 * # **The use of frequency methods in rotorcraft system identification** R W DuVal (NASA Ames Research Center Moffett Field CA) *AIAA SETP SFTE SAE ITEA, and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981*

AIAA Paper 81 2386 9 p

A new approach to model structure determination is examined Flight data from the Rotor Systems Research Aircraft (RSRA) are transformed into the frequency domain and truncated to provide band limiting The stepwise regression technique is then used to identify a quasistatic state space model from the transformed data The data processing requirements for both time domain and frequency domain identification are discussed and the results of the two techniques are compared (Author)

A82 14393 * # **Comparison of wind tunnel and theoretical aeroelastic predictions with flight measured airloads for the B-1 aircraft.** R L Sims and A L Carter (NASA Flight Research Center Edwards CA) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2387* 15 p 13 refs

An aeroelastic analysis of the B 1 aircraft was generated using the FLEXSTAB computer program Relatively simple aerodynamic and structural models were employed Theoretical wing and horizontal stabilizer airloads were compared to wind tunnel predictions and flight data measured during quasi steady pitch maneuvers at Mach numbers of 0 85 and 1 2 with the wing in the 67 5 degree full aft sweep position The basic objective was to evaluate the usefulness of the FLEXSTAB program for pre flight airloads analysis of large flexible aircraft Significant aeroelastic increments were noted between rigid and flexible vehicle results FLEXSTAB predicted airloads for the outer wing panel were in good agreement with measured data for both rigid airloads and elastic increments FLEXSTAB results for the horizontal stabilizer were useful for defining general aeroelastic trends but absolute load levels were not well predicted due to theoretical limitations and difficulties encountered in modelling the complex B 1 configuration Overall the FLEXSTAB program is viewed as a useful integrated tool for static aeroelastic analysis in support of flight programs (Author)

A82 14398 # **Advanced fighter technology integration AFTI/F 16 test program overview** R A Gill and C L Saint Sauver (USAF Wright Aeronautical Laboratories Wright Patterson AFB OH) *AIAA SETP SFTE SAE ITEA and IEEE Flight Testing Conference 1st Las Vegas NV Nov 11 13 1981 AIAA Paper 81 2353* 17 p

The AFTI/F 16 Advanced Development Program objective is to develop integrate and validate advanced fighter technologies to improve air to air and air to surface weapon delivery and survivability The technologies include a Digital Flight Control System Integrated Flight/Fire Control pilot/vehicle interface advancements and advanced flight control modes through direct force control and weapon line pointing Extensive modifications were made to an F 16A for installation of a data instrumentation system modified inlet with canards and a dorsal fairing The AFTI/F 16 is undergoing an extensive test program to provide the confidence necessary to transition the new technologies for retrofit into existing aircraft or incorporation into new fighter aircraft designs (Author)

A82 14407 * **Development of a comprehensive analysis for rotorcraft II Aircraft model solution procedure and applications** W Johnson (NASA Ames Research Center U S Army Aeromechanics Laboratory Moffett Field CA) *Vertica* vol 5 no 3 1981 p 185 216 15 refs

The development of a comprehensive analytical model of rotorcraft aerodynamics and dynamics is described Particular emphasis is given to describing the reasons behind the choices and decisions involved in constructing the model The analysis is designed to calculate rotor performance loads and noise helicopter vibration and gust response flight dynamics and handling qualities and system aeroelastic stability It is intended for use in the design testing and evaluation of a wide class of rotors and rotorcraft and to be the basis for further development of rotary wing theories The general characteristics of the geometric structural inertial and aerodynamic models used for the rotorcraft components are described including the assumptions introduced by the chosen models and the resulting capabilities and limitations Finally some examples from recent applications of the analysis are given (Author)

A82 14414 **The operational characteristics of turbojets, giving particular attention to the cooled high pressure turbine (Zum Betriebsverhalten von Turboluftstrahlantrieben unter besonderer Berucksichtigung der gekuhlten Hochdruckturbine)** W Muggli (Munchen Technische Universitat Munich West Germany) *Zeitschrift fur Flugwissenschaften und Weltraumforschung* vol 5 Sept Oct 1981 p 273 283 6 refs In German

The employment of a gas turbine has great advantages for aircraft provided high operational temperatures and pressures can be used In connection with the current status of technology concerning materials it is necessary to cool engine components exposed to the hot gases The consideration of the cooling processes is an important factor in the determination of the operational characteristics of a turbojet The computation of the local flow conditions in the blading area of a turbomachine is considered and a description is presented of the computational procedures for determining the amount of heat transferred at a cooled blade of the turbine The determination of the amount of air needed for cooling is discussed along with the numerical calculation of the operational characteristics of cooled axial turbines Attention is given to a number of approaches for reducing the amount of air required for cooling in a high-pressure turbine G R

A82 14416 **Wing design for light transport aircraft with improved fuel economy** D Welte R Birrenbach and W Haberland (Dornier GmbH Friedrichshafen West Germany) *Zeitschrift fur Flugwissenschaften und Weltraumforschung* vol 5 Sept Oct 1981 p 294 303 5 refs Research supported by the Bundesministerium fur Forschung und Technologie

Investigations related to the development of a new wing for a light transport aircraft were initiated by a German aerospace company in 1975 Flight tests for the evaluation of the new wing began in June 1979 The considered design incorporates a new wing section and a wing tip having a triangular shape The induced drag observed in connection with the new wing tip is less than the corresponding value found for wing tips of conventional design Tradeoff studies were conducted to optimize wing area and wing aspect ratio for the specified performance requirements A use of the new wing design makes it possible to obtain aircraft with high maximum lift values low drag and good stall characteristics Attention is given to the wing parameter study aspects of airfoil design the flap design the wing design the aileron and the merits of a number of different wing structures G R

A82 14418 **The load carrying behavior of a trapezoidal aluminum alloy supporting element subjected to a compressive stress in the postbuckling region (Das Tragverhalten eines gedruckten Alu Trapeztragers im Nachbeulbereich)** E Schneider (Vereinigte Flugtechnische Werke GmbH Bremen West Germany) *Zeitschrift fur Flugwissenschaften und Weltraumforschung* vol 5 Sept Oct 1981 p 313 323 8 refs In German Research supported by the Bundesministerium der Verteidigung

An analysis is conducted of the behavior of a trapezoidal aluminum-alloy supporting element which is subjected to a compressive force taking into consideration before and after the force reaches the value of the carrying capacity The analysis makes use of the finite element method and takes into account geometrical nonlinearities and the elastic plastic material characteristics of aluminum It is found that the behavior of the supporting element in the postbuckling region can be determined with the aid of the slow ramp method a dynamic computational procedure The magnitude of the considered system damping and the deformation rate selected for the computation are found to have a significant effect on the result A comparison of computed and experimental data shows that it is possible to predict the behavior of the supporting element analytically with satisfactory accuracy G R

A82 14676 **NAECON 1981, Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 19-21 1981 Volumes 1 2 & 3** Conference sponsored by the Institute of Electrical and Electronics Engineers New York Institute of Electrical and Electronics Engineers Inc 1981 Vol 1 460 p vol 2 495 p vol 3 502 p Price of three volumes members $45 nonmembers $60

Topics of aerospace electronics such as the ADA programming

language, inertial systems microcomputer applications survivability and the all electric aircraft were discussed Papers were presented on laser gyros and advanced navigation systems as well as advanced architecture communications, and radar equipment software and avionics and armament planning Failures in high voltage tubes were considered and attention was given to signal processing techniques, integrated aircraft controls, fire control software support tools cost estimates for software and medical technology Emphases were placed on Kalman filter an electronic terrain map EM compatibility aerospace power systems, air traffic control environmental stress measurements fault isolation and multivariable flight control design
M S K

A82-14678 The design and implementation of a canned scenario function for the F 16 dynamic system simulator L Gearhart (Lear Siegler Inc , Astronics Div Dayton OH) and D L Dresel (TRW Defense and Space Systems Group, Dayton, OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference, Dayton, OH, May 19 21 1981 Volume 1 New York, Institute of Electrical and Electronics Engineers Inc 1981, p 10 17

The F 16 Dynamic System Simulator (DSS) is an integrated hardware and software system used to test the F 16 Operational Flight Program (OFP) A major function of DSS is its Canned Scenario the generation of repeatable scenarios for demonstrations and for the verification and validation of the F 16 OFP Development of a canned scenario requires the classification of the dynamic characteristics of the system the inputs outputs, plant and system states Analysis of the system being simulated is paralleled by an analysis of the simulation models The interfaces and models are grouped in blocks according to such characteristics as random or asynchronous versus deterministic behavior An appropriate set of inputs and initial states is defined for the canned scenario function based on the user's needs These initial and input variable sets are incorporated into the software design of the canned scenario and can be recorded and played back in order to repeat the essential behavior of the system The scenario is applied to the F 16 OFP as an example and problems encountered in its implementation are discussed
J F

A82 14682 Strapdown inertial reference systems performance analysis G J Robinette (USAF Avionics Laboratory, Wright Patterson AFB, OH) R C Burns, and R M Schwarz (McDonnell Aircraft Co Avionics Engineering Div St Louis MO) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference, Dayton OH, May 19 21, 1981 Volume 1 New York Institute of Electrical and Electronics Engineers, Inc 1981, p 38 45 7 refs

The Strapdown Performance Study (SPS) program is being sponsored by the Air Force Wright Aeronautical Laboratories to determine where improvements in strapdown inertial technology are required to meet the tactical and strategic navigation and weapon delivery requirements associated with advanced tactical fighters (ATF) and advanced cruise missiles (ACM) of the 1990 s Phase I of this study includes the gathering of data, the development of simulation tools and the methodology for validation of these tools Data were gathered on current inertial instruments and systems, fundamental performance limitations and projected instrument capabilities Mission profiles for the ATF and ACM are used as the basis for establishing performance goals Strapdown inertial system implementation data were used to establish a preliminary inertial system error budget consistent with ATF/ACM performance goals A SIMulated Strapdown Inertial Navigation (SIMSIN) computer program, its development and seven step validation process are described
J F

A82 14684 A failure detection and isolation system for tactical aircraft with separated IMUs P Motyka (Charles Stark Draper Laboratory Inc Cambridge MA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc 1981, p 51 60 7 refs Contract No F33615 78 C 1563

The development and evaluation of a failure detection and isolation (FDI) system for tactical aircraft with two physically separated inertial measurement units (IMUs) are described Each IMU consists of four inertial instruments in a symmetrical conical array The instrument outputs are used for both navigation and flight control reflecting the underlying multifunction inertial reference assembly concept FID is performed using the generalized likelihood test and the thresholds required for FDI are defined Digital simulation results are presented which show the operation of the FDI system over a spectrum of sensor failures and indicate the effects of these failures on navigation errors Results show that it may be feasible to detect and isolate only the first three failures of the dual IMU system Lever arm compensation results in the faster detection of accelerometer failures at the expense of increased computer throughput Finally failures of a magnitude less than the soft failure detection threshold are more likely to be isolated incorrectly
J F

A82 14685 A concept for a high accuracy, low cost accelerometer S G Shutt (Rockwell International Corp Autonetics Div Anaheim CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH, May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers, Inc 1981 p 61 69

A three axis accelerometer is described in which low cross coupling between axes is achieved by a novel electromagnetic forcing system A mechanical proof mass support system is used which has small bias variation in the presence of large parts instabilities, compared to the usual inertial instruments This accelerometer concept has the potential for low cost and high accuracy operation over a wide temperature range An experimental accelerometer was designed built and tested to determine the feasibility of the accelerometer concept The main components of this accelerometer are described first (1) housing and magnet assembly (2) proof mass assembly, (3) pickoff assembly and (4) filament support system Data were obtained for the spring rates the bias and scale factor coupling coefficients the bias instability, and the bias temperature sensitivity All measured parameters were within acceptable calculated values overall operation of the experimental accelerometer was found to be successful
J F

A82 14694 High-accuracy ranging over voice radios for downed aircrew rescue R H Brader (RCA, Government Communications Systems Div Camden NJ) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH, May 19 21, 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981, p 128 133

A high accuracy ranging technique using digital technology and LSI implementation has transformed a conventional military survival walkie talkie into a position location system that helps rescue downed pilots This paper first describes the operational requirements and scenario for a military downed aircrew rescue The basic technique involved in a half duplex ranging system and the specific techniques developed to meet the operational requirements and voice radio constraints are then discussed in some detail The problems discussed are efficient modulations in an AM radio, delay variation control rapid acquisition using a narrow bandwidth radio memory requirements for half duplex operation and digital design for miniaturization
(Author)

A82 14696 High speed microwave phase-locked loops E M Perdue (Raytheon Communication Systems Laboratory Sudbury MA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 140 145 9 refs Research sponsored by the Raytheon Co Contracts No F33615-73 C-4036 No F33615-78 C 1583

A microwave synthesizer scheme is developed which can embody rapid broadband tuning accuracy and resolution for instituting Doppler correction, spectral purity for low data rate transmission remote control and small size for airborne operations The scheme is directly adaptable to any band of communication while providing secure antijamming techniques and the microwave phase locked loop can control and produce an output with excellent phase noise characteristics with spurious levels below 60 dBc at any

point in the band The phase locked synthesizer also meets present switching speed requirements D L G

A82-14705 Electromechanical actuation development program S A Rowe (AiResearch Manufacturing Company of California Torrance CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 206-213 12 refs

A prototype electromechanical actuation system (EMAS) development program for aircraft flight control systems (FCS) was initiated in February 1976 resulting in a working prototype actuation system suitable for aircraft primary FCS applications Tests involving EMAS components performance environment and control/stability are reported and program motivation EMAS description and nomenclature program history and future objectives are discussed D L G

A82 14707 Will power by wire replace power-by hydraulics I S Mehdi (Boeing Military Airplane Co , Seattle, WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 221 228 8 refs

The development of two parallel aircraft actuation and secondary power systems designed within the context of a two engined fighter is discussed One is based on engine extracted hydraulic power while the other is based on engine extracted electric power Consideration is given to actuation system requirements gun and environmental control system requirements secondary power system requirements and temperature parameters Preliminary results are presented for estimates of weights and life cycle costs for each system Factors important for achieving an all electric airplane are identified S C S

A82 14709 The all electric airplane Its development and logistic support M J Cronin (Lockheed California Co Burbank CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH, May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers, Inc 1981 p 241 247 19 refs

Developmental and logistic support aspects that must be considered as a part of the development cycle of potentially large electric power systems are reviewed Increasing fuel problems and their impact on the economic viability of commercial airlines are discussed The hardware design power generation system environmental control system and the engine starting system are also discussed In addition the impact of these large electric power systems on ground logistic support and operation from ground power units, auxiliary power units and fixed plant installations is considered D L G

A82 14710 New all electric system technology C W Clay (Boeing Commercial Airplane Co Seattle WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 248 254

The status of electromechanical actuators (EMA) as a key element in the development of an all-electric aircraft system is investigated It is found that the feasibility of EMA hardware has been amply demonstrated in laboratory systems and an EMA for a research aircraft Attention is also given to a distributed data bus communication system a distributed dc power system questions of overall system integration and the design of a flight deck The reported evaluation study shows that hardware for a complete fly by wire all electric aircraft system is either available or will approach production readiness within a year or so A program to integrate this hardware into a comprehensive single system is highly desirable to enhance development as well as optimize cost and weight benefits G R

A82-14711 Weapon delivery system using GPS A K Aggarwal In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 258 267

It is pointed out that in a highly dynamic vehicle such as a fighter aircraft the GPS User Set is augmented by an Inertial Measurement Unit (IMU) to maintain weapon delivery accuracy during high acceleration maneuvers This GPS Weapon Delivery System furnishes highly accurate placement of air to ground weapons The system uses a digital computer for computing the automatic release signal in conjunction with an Inertial Measurement Unit and a GPS User Set The integrated Weapon Delivery System will work together with a Horizontal Situation Indicator a Vertical Gyro Indicator and/or a Vertical Display Indicator for displaying pilot aiming information C R

A82 14712 Updated station deselection procedures to support automatic Omega receiver operation R D Healy R R Gupta (Analytic Sciences Corp Reading MA) and P B Morris (U S Coast Guard Washington DC) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 268 273 10 refs

Many automatic Omega receivers use a station selection criterion which does not employ specific propagation related tests designed to avoid errors caused by wrong-way paths and westerly signal traverse of the magnetic equator These errors can introduce navigationally significant errors into the Omega position solution which can however be minimized by using the manual station deselection feature of the receiver This paper describes these potential error sources and presents an updated Omega station selection chart containing specific recommendations for station deselection in a number of worldwide locations A simple test for detecting wrong-way path propagation is also included (Author)

A82 14713 Navigation for helicopters by multiple use of inertial sensors V Held (Elektronik System Gesellschaft mbH Munich, West Germany) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 274 282

The paper presents a concept for the inertial functions flight control sight stabilization navigation of a helicopter A minimum number of dislocated inertial sensors is proposed The systems functions are accomplished on a system level by multiple use of the sensor signals It will be proven that attitude and heading can be derived from the flight control and stabilization hardware so that the usually required attitude and heading reference for the navigation is saved Moreover the proposed concept provides as an additional function the autonomous initial alignment to north (Author)

A82 14719 Distributed Time Division Multiple Access /DTDMA/ - A distributed signaling technique for advanced tactical communications J Rubin (ITT ITT Avionics Div Nutley NJ) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 332 337 7 refs Research supported by ITT

The Distributed TDMA concept based on the premise of maximizing the full utility of time frequency and code, is described This multidimensional approach contributes simultaneously to efficient multiple access antijamming and low probability of exploitation (LPE) system solutions The multiple access problem is solved through pseudo random time and frequency hopping coupled with interleaved channelization which utilizes low duty signal structures This random access technique is particularly suited to a Command Control Communication/integrated communication navigation identification system as it provides intra-system and related function interference rejections C R

A82 14720 # Future directions in CNI integrated avionics R L Harris (USAF Avionics Laboratory Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH May 19-21 1981 Volume 1 New York Institute of Electrical and Electronics

Engineers Inc 1981 p 338 344 21 refs

In order to appropriately satisfy the expected communications navigation and identification (CNI) requirements for tactical aircraft of the 1990 s the estimates of volume, weight and cost of these functions must somehow be reduced It is noted that the Air Force and Navy s technology programs for integrated CNI concepts have outlined baselines of current integratable hardware including the functions of HF UHF JTIDS GPS SEEK TALK and IFF interrogator/transponder the programs have also formulated archi tectures for future development Among the developing technologies that affect integrated CNI are very large scale integration (VLSI), very high speed integrated circuits (VHSIC) the future programming language Ada and the development of charge coupled devices (CCD s) surface acoustic wave (SAW) devices magnetostatic wave (MSW) devices and microprocessing The effects on integration are found to be significant C R

A82 14721 # **A modular multiplexed digital voice inter communications system** R F Bolt and J J Seal (U S Navy Naval Avionics Center Indianapolis IN) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH, May 19 21 1981 Volume 1 New York, Institute of Electrical and Electronics Engineers Inc 1981, p 345 349 7 refs

The design and development of a modular multiplexed digital voice Intercommunications System (ICS) for military applications is described This system under development at the Naval Avionics Center, uses a dedicated MIL STD 1553B multiplexed data bus its modular design consists of Weapon Replaceable Assemblies (WRAs) The system architecture will provide integrated radio control using a single data bus that carries both digital voice data and control information This ICS can be configured for a particular aircraft by arranging the various subsystem WRAs to satisfy the weapon system requirements This paper discusses the functional requirements of the WRAs in the digital voice ICS System concepts have been demonstrated in the three station Multiplexed Digital Voice ICS This breadboard system provides ten bit rate/audio bandwidth combinations which have been evaluated for intelligibility in three aircraft acoustic noise environments The intelligibility test results and the results of a package configuration study are summarized (Author)

A82 14723 **Detection range analysis of an airborne medium PRF radar** M B Ringel (Westinghouse Electric Corp , Baltimore MD) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH May 19-21 1981 Volume 1 New York, Institute of Electrical and Electronics Engineers, Inc 1981 p 358-362 10 refs

The detection range of an air to air medium PRF radar is analyzed in terms of the signal processing involved in multiple PRF ranging, the nature of the ground clutter in the range Doppler space defined by such a radar and the radar/target kinematics References containing prerequisite knowledge and similar analysis for other types of radars are cited and the analysis in this paper is compared to previous works A flow chart of a computer program implement ing the analysis outlined in this paper is presented (Author)

A82 14725 **Using phased array radar for data communica tions** H D Lewis (RCA Government Systems Div Moorestown NJ) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 1 New York Institute of Electrical and Electronics Engineers Inc 1981 p 371 376

The idea of using a multifunction array radar at the controlling master station for the additional function of data transmission and reception is introduced Here, cooperating stations equipped with suitable transponders are beacon tracked by the radar providing positive identification of each station as well as highly accurate positional data for the cooperating stations Among the applications of this system are surface to air command and control long-range targeting and track from air to surface and surface to surface coordi nation, including both monostatic and multistatic operations It is pointed out that the high power aperture product and low antenna sidelobes of the phased array radar are inherent characteristics that can be used in combatting ECM What is more the ability of multifunction phased array radar to revisit the cooperating station as often as required permits a reliable interchange of data on an interrogation/rely basis C R

A82 14735 **Computational considerations for fusion in target identification systems** E L Waltz (Bendix Corp Communica tions Div , Ann Arbor MI) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 492 497 29 refs

This paper presents an overview of the computational implica tions of applying multisensor data to the target identification problem Recent efforts to develop a mathematical basis for multisensor correlation (fusion) have been performed by the services and have been directed at local (autonomous) and regional (netted) systems for a wide range of applications These studies have developed algorithms for ASW air air identification battlefield management ocean surveillance and air defense An overview of these fusion algorithms' and their relationship to classical pattern recognition is presented The hierarchical aspects of correlation combination and aggregation are described and their effects on system complexity are discussed Key parameters which characterize the general fusion system are described and related to processing requirements These computational requirements are compared to expected VHSIC/VLSI capabilities to project the potential for integrated fusion processing in advanced avionics and weapons systems (Author)

A82 14739 **Evaluating sources of error in EAR/GEANS navigation using a Kalman postprocessor** S H Musick (USAF, Avionics Laboratory, Wright Patterson AFB OH) and N A Carlson (Intermetrics Inc Cambridge MA) In NAECON 1981 Proceed ings of the National Aerospace and Electronics Conference Dayton OH, May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 520 526 9 refs

EAR/GEANS is an integrated radar/inertial system consisting of a coherent multimode radar EAR and an accurate inertial naviga tion unit, GEANS The EAR radar makes velocity and position measurements that aid GEANS while GEANS in turn supplies EAR with navigation data for measurement control and motion compensa tion In this complex system many error sources affect navigation performance This paper describes an effort to evaluate flight test navigation performance in terms of fundamental sensor error sources The various models and tools that were developed are discussed The key tool is a high order Kalman filter called the Error Isolation Filter used as a postprocessor of flight recorded data Simulated flight test results are presented to demonstrate error recovery performance Performance of the EIF using actual flight data is discussed The paper emphasizes the experiential aspects of the effort (Author)

A82-14740 **The use of observers on relaxed static stability aircraft** R H Rooney and E Y Shapiro (Lockheed California Co Burbank CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 527 533

An observer is a dynamical system that reconstructs the states of a system that is used to drive it Observers can be used when a normally available signal is unavailable due to sensor failure or as a sensor replacement when the use of a sensor may be undesirable due to operational considerations The signal provided by the observer can then be used as an input to a controller for various purposes such as stabilization, optimization, or decoupling The fundamentals of observer design are reviewed and simulation results of observers implemented on Relaxed Static Stability (RSS) aircraft are present ed It is shown that while performance of observers in a RSS aircraft setting is degraded somewhat their use in unstable applications is not precluded (Author)

A82 14741 **Integrated Flight/Weapon Control design and evaluation** W J Murphy (McDonnell Aircraft Co St Louis MO) and W L Young Jr (USAF Wright Aeronautical Laboratories Wright-Patterson AFB OH) In NAECON 1981 Proceedings of the

National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc , 1981 p 536-543 Contract No F33615 79 C 3604

The Integrated Flight/Weapon Control (IFWC) program is aimed at developing integrated flight/fire control technology This includes increasing weapon delivery capabilities, survivability and operability in the delivery of guided weapons and dispenser munitions The completed development of selected concepts through preliminary design is presented pilot in the loop simulation was used for concept refinement and validation The preliminary results based on pilot evaluation, showed that the tactical munitions dispenser weapon delivery system is accurate and provides increased survivability over conventional delivery The air to surface missile delivery system was also found to be good especially in clear daylight conditions The most favorably received feature of the IFWC air to air weapon delivery system was IFFC I/FIREFLY III gunnery which had increased all aspect gun opportunities in precision pointing near head on long range opportunities and high angle off opportunities J F

A82 14742 Software considerations in the design of computer generated flight displays M Miller (HRB Singer Inc State College PA) and A J Aretz (USAF Wright Aeronautical Laboratories, Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 544 548

The use of formats which take advantage of color imagery and the capabilities of a digital computer is one way of presenting information to pilots that is clearly understandable and requires little interpretation The functional requirements of four specific graphic presentations and their impact on the design of the display generation software are discussed The four formats considered are (1) the tactical situation format (2) the stores status format (3) the head up display format, and (4) the integrated flight path format Due to the dynamic nature of the aircraft, the formats are also required to be dynamic, with a minimum update rate of 5 Hz Attempts to simulate flight and generate the integrated flight path format have achieved an update rate of 2 Hz Generating color pictures with computer graphics is essentially a paint by number exercise, where color assignment is determined from a VLT J F

A82 14743 # The influence of smart computers on the cockpit of the future N L Gravely and J O Mysing (USAF Wright Aeronautical Laboratories, Wright Patterson AFB, OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981, p 549 556 7 refs

Recent developments in digital technology at the Air Force Wright Aeronautical Laboratories are presented which will have great impact on the cockpit of the future Characteristics of the Digital Avionics Information System representative of the state of the art in cockpit technology are first discussed Future capabilities to be achieved by artificial intelligence are then outlined flexible cockpit reconfiguration crew decisions aided by computerized systems consultant machines that understand and converse in free text and computer vision that can interpret sensor images A very high speed integrated circuitry (VHSIC) is being developed which would extend and refine the metal oxide semiconductor and bipolar technology to increase through put rates and improve reliability while decreasing size and power consumption Compared to the present F 16 computer the VHSIC would provide a 90% reduction in size volume and weight an 85% decrease in power and a 100% increase in MTBF An intelligent software program (modification of MYCIN /Bernhard 1980/) is being considered which would aid the pilot during in flight system failures Subsystem developments in the areas of graphics and computer generated imagery dynamic pictorial displays image processing and aircraft emergency procedures are also discussed J F

A82 14744 A methodology for missile launch envelope display evaluation G E Corrick (Hughes Aircraft Co Culver City CA) and P V Kulwicki (USAF Aerospace Medical Research Laboratory Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 557 564 Contract No F33615 79 C 0508

A methodology for objective evaluation of advanced display formats is described A computer generated manned non interactive single target air combat simulation was used to evaluate two advanced VSD (vertical situation display) and HUD formats with respect to current F 15 air combat displays The principal performance measures obtained were pilot responses to questions about the simulated engagement and a measure of the cognitive workload imposed by the format assessed by the Sternberg reserve capacity task The pilots comments and opinions were also obtained in a post evaluation debriefing Nine operational Air Force pilots were subjects Results showed no large differences in performance on mission questions across formats but large differences in imposed cognitive workload All HUD formats imposed more workload than VSD formats and there was a strong correlation between the objective results and subjective opinions (Author)

A82 14745 # Assessing pilot workload Without disturbing pilot behavior R J Elder (USAF Warner Robins Air Logistics Center Robins AFB GA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 2 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 565 571

The need for the design of practical pilot workload assessment techniques which do not obstruct the normal operational procedures of the pilot subjects is discussed An analysis of the pilot tasks in an air-to air engagement is presented Workload assessment techniques are analyzed for their applicability to the single seat fighter environment The procedure for design of an experiment using these techniques is demonstrated for an F 15 air to air engagement Applications of the method in weapon system modification and operational training evaluation are discussed (Author)

A82 14750 Evaluation of advanced air to air gunnery fire control systems N M Shah and J Stalony Dobrzanski (Northrop Corp , Aircraft Div , Hawthorne, CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc , 1981 p 615 622

Three advanced fire control systems based on the director type radar fire control system were designed for an advanced fighter aircraft These systems are fixed gun trainable gun and integrated fire flight control (IFFC) In addition an automatic range control (ARC) system which uses radar information for maintaining range with respect to target was designed The air combat performance with each system was evaluated on the simulator with realistic radar noise and hardware constraints The ARC was evaluated with fixed gun only The results show definite superiority of the trainable gun even with relatively modest gun travel and servo power over a fixed gun and IFFC The trainable gun IFFC and ARC concepts provide improved tracking performance with considerable reduction in pilot workload over the fixed gun The time to achieve first hit is shortest with the trainable gun The ARC enhances survivability by minimizing overshoots with respect to the target (Author)

A82 14759 # Assessment methodology of the lightning threat to advanced aircraft R A Perala (Electromagnetic Applications Inc Denver CO) and G A DuBro (USAF Wright Aeronautical Laboratories Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 691 697 19 refs

An overview of an assessment methodology concerning the lightning susceptibility of aircraft is presented Work in this area is concentrated on increasing the general understanding of the physics of the aircraft lightning interaction and on developing specific laboratory threat simulation testing techniques Recent advances in both testing/simulation and analytics are discussed These advances have been made possible by the incorporation of nuclear electro

magnetic pulse technology and recent indications from measure ments of natural lightning which suggest that significantly greater electromagnetic energy exists in the frequency range where increased coupling of such energy to the aircraft is possible B J

A82 14760 The Navy F/A 18A Hornet electromagnetic compatibility program J R Ketterer (McDonnell Aircraft Co St Louis MO) and J J Fisher (U S Naval Air Systems Command Washington DC) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 698 702

The F/A 18A Hornet is a first line carrier deployed aircraft employing advanced composite structures and state of the art digital electronics Because the electromagnetic environment (EME) generat ed on present day carrier decks can reach field strengths over 10 000 Volts/meter at some frequencies electromagnetic compatibility (EMC) challenges were presented The approach to aircraft EMC design established for the F/A 18A required using the airframe as an enclosed electromagnetic (EM) shield This shielding concept allowed equipment located within the airframe shield to be designed to a less severe EM environment than equipment located outside the airframe shield Using the airframe as an electromagnetic shield presented a significant challenge particularly because graphite/epoxy composites represent more than one third of the F/A 18A surface area Overall this concept was found to represent the least cost weight and design impact both to the airframe and to the electrical or electronics equipments (Author)

A82 14761 A recursive time domain analysis of dis tributed line grid networks with application to the LTA/EMP problem W S McCormick (Wright State University Dayton OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers, Inc , 1981, p 703-708

Modeling the aircraft fuselage as a two node TEM lossy distributed network, a recursive time domain technique is presented to estimate the fuselage skin current induced by a remote lightning strike The technique involves the determination of the two discrete nodal transfer functions followed by an application of Duhamel s theorem to the distributed electromagnetic excitation case The Fourier transform of the induced fuselage skin current is presented as a function of the azimuth and elevation angles of the incident plane electromagnetic lightning excitation Reference to the PORTER and NOAA flight programs is made along with a discussion of future application areas (Author)

A82 14762 New advances in signal processing technology for integrated CNI avionics C R Ward and R A Reilly (ITT ITT Avionics Div Nutley NJ) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 712 722 20 refs

Functionally integrated CNI (communication navigation and identification) radio systems appear to be attractive as a means of resolving size and weight conflicts between conventionally designed radio systems on space limited tactical military aircraft In practice integration is often frustrated by basic incompatibilities between widely divergent signal structures Although there are many very complicated aspects to the problem of functional integration this paper addresses only the problem of accommodating the reception of different signal structures efficiently and flexibly in the RF to baseband domain A radically different approach to radio receiver design is proposed which employs high speed digital and/or CCD technology which could be ready for field deployment by the 1990 time frame Several alternative system level architectures are pro posed and the tradeoffs between them evaluated (Author)

A82 14763 Advanced integrated CNI architectures P C Camana S K Ogi and L R Stine (TRW Defense and Space Systems Group Redondo Beach CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 723 728

Integrated terminal architectures can produce a modern CNI (communications navigation and identification) system at an affordable life cycle cost within real estate requirements Major considerations include use of common modules RF and digital large scale integration (LSI) technology insertion and high performance programmable digital signal processing The RF subsystem consists of conventional RF and IF chains of common modules combined with the RF LSI technology The digital processing subsystem is an array of programmable signal/data processors with the core element being a VLSI 100 MIPS single card signal processor Common modules network reconfigurability and high level of integration will provide for lower life cycle costs with reduced systems size weight and power dissipation (Author)

A82 14765 The agile transversal filter A flexible building block for ICNIA D G Botha (USAF Wright Aeronautical Labora tories Wright Patterson AFB OH) and F W Smead (ITT ITT Avionics Div Nutley NJ) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers, Inc 1981, p 735 740 USAF sponsored research

Integrated Communications Navigation and Identification Avionics (ICNIA) is an advanced development program to demon strate an integrated systems approach to the implementation of functions normally performed by a collection of independent black boxes The system design partitions all CNI functions to optimize modular commonality within the ICNIA system One function required in many parallel channels is the processing of signals with instantaneous bandwidths of 10 MHz or less A specific implementa tion is the Narrow Band Agile Transversal Filter (NBATF) which can be implemented in state of the art technology can process signals with a variety of algorithms selectable under software control and can be replicated within the system, as required to perform the total set of functions The NBATF constitutes a building block module within the ICNIA system (Author)

A82 14767 Applications of covariance analysis simulation to avionics flight testing A Foote C Vellenga J Price and W Buchholz (Logicon Inc Dayton OH) In NAECON 1981 Proceed ings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 750-756

The application of covariance analysis simulation techniques to the conduct of developmental flight test of integrated navigation systems is presented In particular this paper describes how covariance analysis simulation techniques are being used in the planning execution and analysis phases of the B 52 Offensive Avionics System (OAS) flight test and discusses how they may be applied to future testing The mission flexibility of modern strategic aircraft and the built in redundant modes of operation define a large number of scenarios which must be tested The role of covariance analysis simulation techniques in the B 52 OAS flight test is to assist in the planning and execution phases and to provide information supplemental to actual flight test results Discussions of the use of covariance analysis simulation techniques in each of these test phases are presented together with a sample of results from a B 52 OAS flight test (Author)

A82 14768 Application of multiple model estimation techniques to a recursive terrain height correlation system W Tang and G L Mealy (Analytic Sciences Corp Reading MA) In NAECON 1981 Proceedings of the National Aerospace and Elec tronics Conference Dayton OH May 19 21 1981 Volume 2 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 757 764 Grant No DAAK80 79 C 0268

This paper describes the results of a study which determined the performance capabilities of a recursive terrain correlation system proposed for low altitude helicopter navigation A Monte Carlo simulation program was developed to assess the effectiveness of the terrain correlation algorithm The sensitivity of the system to various error sources was evaluated and filter modifications to enhance system performance were proposed An alternate configuration based upon multiple model estimation techniques was shown to afford a substantial decrease in system sensitivity to initial position uncertainty (Author)

A82 14769 # **Algorithms for an adaptive dynamic window in electronic map systems** D L Sander (USAF Wright Aeronautical Laboratories Wright Patterson AFB OH) In NAECON 1981 *Proceedings of the National Aerospace and Electronics Conference* Dayton, OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 766 768

Algorithms have been developed for an adaptive dynamic window which closely conforms to irregular shaped areas These algorithms advance the window as the aircraft moves adapt it to new geometries as they evolve and provide for buffer zones in advance of expected movement and maneuvers This paper describes these algorithms following a brief discussion of past and present dynamic window techniques used by the Air Force Wright Aeronautical Laboratories Avionics Laboratory (Author)

A82 14770 **Airborne Electronic Map Systems I Design** R Hoffman and G Burnham (Texas Instruments Inc Dallas TX) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 769 772

The requirements and implementation of an Airborne Electronic Terrain Mapping System (AETMS) are discussed Display formats with plan views flat images and perspective views all comparable to window or boresight images or viewpoints other than the pilot s simulation of aircraft motion at speeds up to Mach one and cost effectiveness i e minimum cost and interface capabilities are mentioned as necessary aspects for simulation or in flight use The data flow comprises a series of refinements of raw terrain data and time dependent user parameters and the limiting factor of storing only pertinent regional data for airborne use due to technological weight restrictions for stored memory is stressed Processing and regional memory selection are examined including the use of up to 13 multipliers and 60 adders to perform up to 80 million operations/sec for a full range of CRT image generation M S K

A82 14771 **Airborne Electronic Terrain Map System** J W Weber and E W Opittek (Hughes Aircraft Co El Segundo CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 773 778

The paper reports on the Airborne Electronic Terrain Map System Program which has resulted in the development of a flyable brassboard for the evaluation of display applications for the Defense Mapping Agency digital data base A summary of the display formats and supporting simulations such as the plan view contour and perspective views is given and a system description is presented which reviews features such as the regional memory display generator software and support equipment D L G

A82 14772 **Passive terrain following using stored map and global positioning system** A C Woodward and W M Hoover (Texas Instruments Inc Lewisville TX) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 779 785

The configuration and preliminary results are presented for a flight test program conducted to illustrate the potential for passive terrain following (TF) flight by combining current map storage the NAVSTAR Global Positioning System (GPS) and TF algorithm technologies Primary aspects of the GPS/MAP TF system and flight test program include terrain profile descriptions GPS position and aircraft state information and TF command computation Results indicate that position/map techniques can be used in low level flight control and eventually operational systems should control primarily from position and map information D L G

A82 14773 **Airborne Electronic Terrain Map System II Applications** G Burnham and C S Kline (Texas Instruments Inc Dallas TX) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 786 789

Applications of the Airborne Electronic Terrain Map System are considered These include (1) the provision of covert all weather weapon delivery for combat aircraft (2) the use of stored terrain data to substitute for data normally provided by a forward looking sensor (3) the use of stored terrain data to generate a display that the pilot can use to fly low and avoid terrain higher than aircraft altitude and (4) the extension of the system to sensor blending concepts with radar and FLIRs S C S

A82 14774 **Technical/operational ATC scenarios for future TMA navigation** K D Kricke and L Knapp (Elektronik System Gesellschaft mbH Munich West Germany) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 792 799 8 refs

Air traffic control is discussed in terms of the entire air traffic system and as a national authority The terminal maneuvering area (TMA) is considered with reference to typical configurations approach and departure phases and such areas for improvement as possibilities for increased capacity environmental protection and fuel saving flight profiles A number of possible advances in TMA scenarios are identified including three and four dimensional navigation secondary radar systems and data processing systems for automated air traffic control S C S

A82 14775 **Some Italian research for developing new primary ATC radars** M Calamia (Firenze Universita Florence Italy) In NAECON 1981, *Proceedings of the National Aerospace* and Electronics Conference, Dayton, OH, May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers, Inc 1981, p 800 807 15 refs

A survey of Italian research on primary air traffic control radar systems is presented Types of clutter affecting such systems are discussed, and the parameters defining the filter capacity of radar with respect to clutter are identified as the improvement factor and subclutter visibility Studies conducted to characterize dynamic clutter phenomena at airports in Rome and Naples in 1979 1980 are reported Attention is given to adaptive moving target indicator filtering techniques A method for the recording and analysis of atmospheric clutter echoes using an orthogonally polarized double channel receiver is considered S C S

A82 14776 **Performance evaluation of target report extractor in the monopulse ATCRBS** D Giuli M Fossi (Firenze, Universita Florence Italy) and E Dalle Mese (Pisa Universita Pisa Italy) In NAECON 1981, Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 808 815 11 refs Research sponsored by the Consiglio Nazionale delle Ricerche

In this paper some results are reported obtained via an analytical approach which are relevant to the performance evaluation of an Air Traffic Control Radar Beacon System (ATCRBS) monopulse extractor to be devised in a Discrete Address Beacon System (DABS) for Air Traffic Control (ATC) Suitable statistical models of the correlation tests used by the dwell time section of the receiver are developed The obtained results refer to a statistical analysis of the dwell time section which performs the defruiting function (Author)

A82 14777 **A multimicroprocessor system for ATCRBS monopulse data processing** E Borgheresi D Giuli F Pirri (Firenze Universita Florence Italy) G Oppimiti and C Poli (Marina Italiana Istituto G Vallauri Leghorn Italy) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 816-822 Consiglio Nazionale delle Richerche No 80 00385 91

In this paper the problem of the dwell time processing of aircraft replies in the Air Traffic Control Radar Beacon System (ATCRBS) section of the Discrete Address Beacon System (DABS) is considered A solution is suggested which is based on the use of a multimicroprocessor system A brief description of the hardware structure of the system is given and the algorithms used for processing the replies are shown Such algorithms aim at improving

the efficiency of correlation procedures among reply reports received by the same target during the antenna dwell time Parallel processing is obtained through a sliced azimuth subdivision of the amount of the total job (Author)

A82 14778 Flight management systems for modern jet aircraft R H Farmer (General Motors Corp Delco Electronics Div Goleta, CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 823 829 Contract No F09603 79 C 1610

Attention is given to flight management computer systems for modern jet aircraft noting tests run on Air Force C 141 aircraft Fuel saving aircraft operations are identified including optimum takeoff and climb schedules cruise Mach control optimized altitude selection delayed flaps ATC flow control and area navigation/direct routing Data from the C 141 Fuel Savings Advisory System are reported In this system the flight management system provides vertical navigation speed control flight planning control and horizontal flight path commands to the inertial navigation systems The data show that significant fuel savings are possible by close attention to many small efficiencies of flight operations S C S

A82 14779 Weather impact on low altitude imaging infrared sensors in Europe An availability model E R Edge (Analytic Sciences Corp Reading MA) J D Malick and J H Allen (SRI International Menlo Park CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH, May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 832 839 5 refs

This paper discusses the development of a methodology for evaluating the availability of low altitude electro optical (EO) sensors for imaging of ground targets Because of the wide range of possible target types and their possible geographical distribution a flexible tool for the assessment of current and future sensor designs is presented This analysis tool which is available as a FORTRAN computer program named WEATHER includes a statistical model of all weather effects, accounts for seasonal diurnal and geographical variabilities allows for arbitrary distributions of targets and provides estimates of simultaneous outages over wide geographical areas (Author)

A82 14780 Study of the effects of maneuver compensation on beam pointing accuracy D E Miracle (Logicon, Inc Dayton, OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 2 New York Institute of Electrical and Electronics Engineers Inc 1981 p 840 846 Contract No F33657 78 C 0490

It is commonly necessary to aim an airborne antenna consistently at a target antenna This aiming is simple enough when angle measuring resources are devoted to the target but these resources are available only a small fraction of the time Consequently with no compensation during maneuvers and between measurements the antenna may be aimed significantly off target Consideration of this problem for present medium performance aircraft having state of the art navigational and EW systems indicates that several simplifying mathematical approximations are justifiable These lead to a set of compensation algorithms which are operationally and computationally superior to known alternative methods The method involves performance angle measurements at a slower rate than is normally required relying upon a set of intermediate pointing corrections for coverage maintenance The forms of the algorithms are simple enough to permit implementation on the EW computer or if necessary, other hardware (Author)

A82 14788 Conceptual design of an integrated power and avionics information system G L Dunn and P Leong (Boeing Military Airplane Co Seattle WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 954 962 5 refs Contract No F33615 80 C 2004

A nonintegrated DAIS type architecture has been used as a baseline to determine power system control requirements for a two engine tactical aircraft and to assess the relative merits of the hierarchical and integrated architectures Two power generation and distribution configurations using solid state power controllers three power control system concepts and two integrated power and avionics architectures were considered It is found that the integrated architectures with smart ELMCs (electrical load management centers) represents the best utilization of the data bus and has acceptable processor loading The processor overhead is the least and both logical equation processing and bus loading make optimum use of the available DAIS technology capabilities for a single data bus P T H

A82 14789 60 kVA ADP permanent magnet VSCF starter generator system A program overview R C Webb (General Electric Co Binghamton NY) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 963 965 Contracts No F33615 78 C 2200 No F33615 74 C 2037

The paper reviews an Air Force sponsored program to design construct demonstrate flight worthiness and flight test 60 kVA variable speed constant frequency (VSCF) permanent magnet (PM) electrical starter/generator systems using high energy product samarium cobalt magnets in an all metallic solid rotor PM VSCF system offers a significant improvement in electrical generating system efficiency over presently used systems The PM VSCF also offers a simplification of the engine auxiliary gearbox area and aircraft ducting by combining the engine starting and electrical power generation functions into one system P T H

A82 14791 High speed PMG containment study for VSCF system M M Youn (General Electric Co Erie PA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 971 977 6 refs Contract No F33615 80 C 2032

A permanent magnet rotor containment method chosen for variable speed constant frequency (VSCF) applications is described The containment method employs amortisseur bars in the magnetic member of the bimetallic shrink ring to reduce the commutating reactance of the generator for stable converter operation The significantly higher energy product combined with high temperature capability of the magnet provides the basis for permanent magnet machines which are smaller higher in efficiency and more reliable than wound rotor machines P T H

A82 14792 Failure analysis of variable reluctance stepper motor D L Hart and J A Ziegenhagen (Dayton University Dayton OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 978 982

The variable reluctance stepper motor is an integral part of the electronic fuel control system on a jet engine in that it regulates the fuel flow to the engine The stepper motor is required to operate in a high temperature environment while immersed in a jet fuel This paper reviews the failure modes analysis techniques and the recommended corrective actions (Author)

A82 14793 The payoff from U S investment in aeronautical research and development R C Lenz (Dayton University, Dayton OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 984 991 NSF Grant No SRS 79 10397

This paper presents a quantitative analysis of the returns on U S investments in aeronautical research and development over the fifty years from 1926 to 1976 The returns on the investment are those obtained through productivity improvements in the airline industry independently of any other returns The net gains from the R&D expenditures are very large in comparison with standard commercial

opportunities during the same period However neither the aircraft builders who performed most of the R&D nor the airlines who bought and used the aircraft received the largest part of the gain Instead the gains were distributed primarily to the traveling public and to a lesser extent to airline employees A key point of the research is the construction of probable aeronautical R&D expendi tures for the years before 1957 the first year for which National Science Foundation statistics are available Another feature is the use of seat mile data as the appropriate measure for airline output in the productivity calculations An innovative concept the use of hypo thetical phantom fleets' to determine productivity gains is intro- duced (Author)

A82 14794 Parallel processing applied to digital flight control systems Some perspectives T F Westermeier (McDonnell Aircraft Co St Louis MO) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1010-1017

Parallel processing techniques are thought to have the potential for increasing the performance of digital flight control systems A number of issues are addressed to determine if the potential can be realized The composition of generic flight control software is examined to determine its amenability to parallel solution From this examination two prototype software decomoositions and their resulting architectures are proposed and evaluated in terms of iteration rate transport lag and computation time The impact of parallel processing on size weight power and reliability is examined next Finally the throughputs of microprocessors are evaluated to determine their suitability as processing elements (Author)

A82 14796 Microprocessor flight control application study F C Neebe S J Hissong (General Electric Co Binghamton NY) and W E Nelson Jr (Northrop Corp Aircraft Div, Hawthorne CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference, Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1022 1029

Digital flight control computers are now being used to imple ment control functions on high performance military aircraft Microprocessor technology has advanced to the point where it is possible to implement many simple control functions Several microprocessor subsystems working in parallel can be used to set up systems which have extensive control capability This paper describes the results obtained from setting up a small microprocessor system to perform pitch control for a modern lightweight fighter aircraft Information is presented detailing system configuration and re sponse (Author)

A82 14814 Implementing the DAIS executive S W Behnen (Boeing Military Airplane Co Seattle, WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc, 1981, p 1149 1154 8 refs

The Boeing Military Airplane Company has been studying the feasibility of applying the DAIS executive to a production aircraft system The advantages and disadvantages of implementing a member of the DAIS executive family have been investigated for several existing and projected aircraft systems new and upgraded avionics systems flight control systems and an electrical power distribution and control system Although certain operational requirements for these systems will entail enhancements in the current executive design the basic philosophy and structure of the DAIS executive make it desirable in each of these systems As a result of its favorable review of the DAIS executive BMAC is proposing to use DAIS executive variants on new systems such as an electrical power and distribution system and an avionics system The decision to implement a DAIS executive in an upgraded version of an existing system will depend on the result of cost/benefit trades (Author)

A82 14817 A storage device for subsystem maintenance information C J Tavora and H M Collins (Houston University Houston TX) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1170-1174 Contract No F33615 80 C 1095

This paper describes the Electronic Nameplate (ENP) an electronic storage device which may be attached physically to avionic subsystems to store information relevant to their identification interface specifications calibration procedures fault isolation tests and operational performance The ENP can be integrated into a single chip device with a standard connector through which it receives power and communicates Prototypes of the ENP have been implemented and tested for the Air Force Wright Aeronautical Laboratories (Author)

A82 14819 Computer modeling of an aircraft HVDC electrical system J D Segrest (U S Naval Material Command, Naval Air Development Center Warminster PA) and D L Sommer (Boeing Military Airplane Co Seattle WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1192 1199 11 refs Contract No N62269 79 V 0265

This paper describes the development of mathematical models which represent typical 270 VDC aircraft electrical systems and the analysis of these models on the EASY Model Generation and Analysis Program The mathematical models of the following components of a high voltage dc (HVDC) electrical system were developed (1) buck multiple loop switching regulator with EMI input filter (2) dc solid rotor generation system (3) dc wound rotor generation system (4) flat conductor distribution bus and (5) aircraft load The EASY program is then used to analyze a system by specifying the topology of a network of these predefined compo nents Sample simulation results are included (Author)

A82 14820 Digital simulation of aircraft electrical generat ing system by means of Sceptre program D Fair J Dhyanchand, E Parker and H Bahanassy (Sundstrand Advanced Technology Corp, Rockford IL) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1200 1205 5 refs

A computer program is presented which simulates the aircraft electrical generating system In this computation analysis a constant speed drive with electronic governor brushless aircraft ac generator and voltage regulator are simulated as a system These subsystems were linked for a complete aircraft electrical power generating system by means of the Super Sceptre program and FORTRAN subroutines The 60 KVA Sundstrand Aircraft Generating System was simulated with this model for on off transient loads The simulated results were found to be in close agreement with experimental data (Author)

A82 14821 Computer simulation of an advanced aircraft electrical system A J Marek D F Sellers (Vought Corp Dallas TX) and D Fox (USAF Wright Aeronautical Laboratories Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1206 1215

Computer simulation programs which were developed for advanced aircraft electrical system designs are described The programs consist of four separate modules encompassing the IDG generating system VSCF generating system parallel generator operation and the power distribution system Each program is written in FORTRAN V and is based on data supplied by power generating system manufacturers and data derived from various texts This paper describes the procedure for program development program features structures parameters and accuracy and program solution run times The capabilities of the developed programs are discussed and a representative sample of simulation runs with computer plots are presented P T H

A82 14823 # Airborne color CRT displays H L Warus zewski Jr (USAF Aeronautical Systems Div Wright Patterson AFB, OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21

1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1224 1243 15 refs

It is suggested that new human factors data and cockpit requirements need to be developed and applied to color cockpit displays so that requirements for a usable display can be generated The color display technology needs to be evaluated with regard to satisfying the established human factors requirements Test methodologies need to be developed to determine the compliance of the color displays with the specification requirements In addition color displays need to be integrated into the cockpit using total cockpit human factors criteria to maximize the possible workload reduction and safety of the aircraft Such color display technologies as beam penetration color CRT and shadow mask color CRT are described and applications of color CRTs (including tactical and map displays and flight control and engine displays) are considered P T H

A82 14824 The Maneuvering Flight Path Display A flight trajectory solution display concept J F Watler Jr and W B Logan (Northrop Corp Aircraft Div Hawthorne CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH, May 19 21 1981 Volume 3 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 1254 1260 5 refs

The Maneuvering Flight Path Display (MFPD) provides to the pilot an anticipatory, real time presentation of the command flight path The presentation depicts the 'solution' of the desired trajectory, thus telling the pilot 'what to do and 'how to do it This information is displayed graphically eliminating the need for the traditional dials, scales pointers, or alpha numeric readouts The pilot by controlling the aircraft to fly just above the graphical flight path being portrayed, is assured of precise 4 D trajectory control It is concluded that the success of the MFPD development and the consequent rapid maturation of the concept has stimulated a widespread interest in advancing the program to flight demonstration as quickly as possible P T H

A82 14825 # The LANTIRN wide field-of-view raster Head-Up Display R L Berry and J C Byrd (USAF Aeronautical Systems Div Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH, May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers, Inc 1981 p 1261 1268

As part of the Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) System, a new Head up Display (HUD) is being developed as replacement for the existing HUDs in the F 16 and A 10 aircraft The primary improvements will be greatly increased field of view and the capability to display Forward Looking Infrared (FLIR) video The HUD will use diffraction optics in the combiner as the main tool by which improvements in field of view contrast ratio and see through visibility are achieved This paper is an overview of the use of diffraction optics in the LANTIRN HUD (Author)

A82 14826 Enhanced aircraft handling qualities by longitudinal dynamics mode decoupling H Y Kim R H Rooney, and E Y Shapiro (Lockheed California Co Burbank, CA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton, OH May 19 21 1981 Volume 3 New York, Institute of Electrical and Electronics Engineers Inc 1981 p 1270 1275

The present paper investigates decoupling procedures using output feedback on longitudinal axis dynamics of a wide body transport aircraft The possibility of decoupling through output feedback is rather restrictive compared to the possibility of full state feedback Therefore when output feedback decoupling is not possible the state variables are reconstructed by the Luenberger observer to be used in full state feedback decoupling of the system The results of this approach are presented via simulation (Author)

A82 14827 A synthesis technique for highly uncertain and interacting multivariable flight control systems I Horowitz O Yaniv B Golubev and L Neumann (Weizmann Institute of Science Rehovot Israel) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19-21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1276 1283 7 refs Grant No AF AFOSR 80 0213

A recent synthesis technique has the attractive property that the uncertain multiple input output (MIO) feedback problem is converted into a number of uncertain single loop problems Under certain general conditions the solutions of the single loop problems are guaranteed to be satisfactory for the MIO problem This technique is applied to the Ay direct side force mode of a fighter CCV aircraft The objective is to achieve fast Ay response with small sideslip and roll over a range of flight conditions Three designs of varying complexity are presented with simulation results The technique clearly reveals the conflicting design factors and trade offs (Author)

A82 14828 # Direct digital design method for reconfigurable multivariable control laws for the A 7D Digitac II aircraft. D W Potts (USAF Flight Dynamics Laboratory Wright Patterson AFB OH) and J D Azzo (USAF Institute of Technology Wright Patterson AFB OH) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21, 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1284 1291 8 refs

This paper investigates control of an aircraft when there is a primary control surface failure The object of this study is to reconfigure the remaining control surfaces to compensate for the additional forces and moments generated by the inoperative control surface To study this flight control problem a comprehensive aircraft model is required which considers each control surface operating individually A six degree of freedom aircraft model is developed including all the individual control surfaces The additional coupling between the axes requires the derivation of several new non dimensional control derivatives With the new comprehensive aircraft model the entire eigenstructure assignment method is used to assign both the eigenvalues and the eigenvectors to the closed loop plant matrix This method is used for the direct digital design of a multivariable discrete regulator control law (Author)

A82 14829 Design of direct digital flight-mode control systems for high performance aircraft B Porter and A Bradshaw (Salford University Salford Lancs England) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference, Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981 p 1292 1298 5 refs Contract No F49620-81 C 0026

The general results of Bradshaw and Porter (1981 1981) on discrete time tracking systems are used to design fast sampling error actuated digital controllers and associated transducers which effect fuselage pitch pointing and vertical translation maneuvers in the case of the F 16 aircraft It is thus demonstrated that these severe maneuvers can be readily effected by appropriate fast sampling error actuated digital controllers which generate practically acceptable flaperon and elevator deflections Furthermore it is also demonstrated that such fast sampling digital controllers are extremely robust (Author)

A82 14831 General purpose real time interaction panel for digital simulation M T Lansdaal and M E McSharry (Boeing Military Airplane Co Advanced Airplane Branch Seattle WA) In NAECON 1981 Proceedings of the National Aerospace and Electronics Conference Dayton OH May 19 21 1981 Volume 3 New York Institute of Electrical and Electronics Engineers Inc 1981, p 1305-1310

Real time simulations for modelling aircraft or flight control systems often need a controlled real time event insertion and event monitoring capability This capability is necessary to study the responses of the simulated system to controlled events or disturbances A description is presented of an approach providing the solution of event/fault insertion and event monitoring requirements The approach makes use of an intelligent device known as the Fault Insertion Panel (FIP) which consists of a minicomputer with a Multiprocessor Communications Adapter a Direct Memory Access I/O board a video terminal and a hand held control box The FIP is an inexpensive and versatile replacement for special purpose hardware such as an aircraft cab/flight deck and analog instrumentation that must interact with a digital simulation G R

A82 14856 **AN/TPN 25 and AN/GPN 22 precision approach radars** H R Ward (Raytheon Co Wayland MA) In International Radar Conference Arlington VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 26 31

A Precision Approach Radar (PAR) is used in a Ground Controlled Approach (GCA) aircraft landing system to make accurate aircraft position measurements during the final approach to the runway The PAR recently developed for the U S Air Force uses a limited scan phased array to scan acquire and track landing aircraft This paper describes the transportable and fixed site models of this PAR as well as the results of field tests to verify their coverage and measurement accuracy (Author)

A82 14857 **Radar hostile fire location** D J Colliver (Royal Signals and Radar Establishment Malvern Worcs England) and J D Holcroft (Racal MESL Linlithgow Scotland) In International Radar Conference Arlington VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 32 37

Methods for detecting an attack involving the firing of projectiles are considered taking into account also the determination of the direction to the source of fire It is found that for the considered objective radar based approaches have important advantages compared to other methods The requirement for the radar to track projectiles down to short ranges favors the use of a CW system and Doppler processing Suitable radar hardware is discussed along with aspects of signal processing taking into account a hybrid processor and a digital processor Radar systems of the considered type are used in fixed and mobile installations in a security role and have also been installed covertly in armored VIP limousines Other applications are related to a battlefield environment G R

A82 14868 **Commercial airborne weather radar technology** G A Lucchi (RCA Avionics Systems Div Burlington MA) In International Radar Conference, Arlington VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 123 130

From World War II until very recently there has been little change in the technology of commercial airborne weather radar The technique being used is still based on the concept of differentiation between various radar backscatter intensities which can be related to rainfall rate The radar backscatter coefficient for various rainfall rates has been determined sufficiently well for weather radar design calculations Experiments continue at this time because there are widespread backscatter coefficients depending on such variables as temperature raindrop size raindrop shape and turbulence in the storm cell Two aircraft were equipped for the conduction of airborne experiments in an attempt to better correlate radar signals with measured turbulence in storm cells At least three radar manufacturers are developing airborne weather radar systems complying with a new characteristic for a weather radar Recently a low-cost weather radar system which can be mounted in the leading edge of a single engine aircraft wing was introduced G R

A82 14871 **Inverse SAR and its application to aircraft classification** G Dike R Wallenberg (Syracuse Research Corp Syracuse NY) and J Potenza (USAF Rome Air Development Center Griffiss AFB, NY) In International Radar Conference Arlington, VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 161 167

Two-dimensional radar images of aircraft have been simulated with parameters similar to those of the ARPA/Lincoln C Band Observables Radar (ALCOR) which has been used in actual radar imaging studies Development of such a simulation program was necessitated by a need to provide a controlled flight situation to study aircraft image projection planes and a desire to use the simulation to aid in developing sorting algorithms for use in aircraft classification The classification approach taken avoids the problem of extraneous responses due to multiple rays engine modulation internal antenna scanning and the addition of stores to the unknown aircraft A degree of insensitivity to poor focusing is also expected B J

A82 14881 **Air to-ground MTI radar using a displaced phase center phased array** M L Stone and W J Ince (MIT Lexington MA) In International Radar Conference, Arlington VA April 28 30, 1980, Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 225-230 5 refs USAF sponsored research

An airborne MTI radar capable of performing surveillance of tactical targets has been assembled and field tested The design features an electronically scanned displaced phase center antenna an advanced digital signal processor and real time automated target acquisition and display The radar represented a scaled model of an all weather long range system Results obtained in the rejection of clutter the detection of moving targets and the acquisition and tracking of targets are discussed (Author)

A82 14908 **A new approach to radar plot extraction for ATC applications** N Accarino and E Giaccari (Selenia S p A Rome Italy) In International Radar Conference Arlington VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 391 396

It is noted that the capabilities of modern ATC radars require more effective target coordinate evaluation and target resolution capabilities in the extractor than have been available in the past The availability of powerful processing tools such as microprocessors makes possible the implementation of sophisticated algorithms to provide optimum radar plot extraction A new extraction algorithm implemented by means of a simulation approach is described The improvement in performance is extensively compared with the values obtained using a conventional extractor The approach described here is given in terms of the following improved characteristics range and azimuth accuracy range and azimuth resolution and target qualification C R

A82 14909 **Extended time radar raw video recording** R Inagaki and M Mochii (Nippon Electric Co Ltd Tokyo Japan) In International Radar Conference Arlington VA April 28 30 1980 Record New York Institute of Electrical and Electronics Engineers Inc 1980 p 397 402

An attempt is made to develop extended time recording of the radar video for analyzing air traffic control accidents The combination of a commercial time lapse video cassette tape recorder and sophisticated video time compression techniques with radar band width compression demonstrates its validity in realizing 32 hour recording of the ARSR video without deteriorating its image quality from a practical point of view Improvement in some circuit instability will make it possible to put this newly developed equipment into actual operation in association with magnetic tape recording of the processed digital radar data C R

A82 14927 * **The X 14 24 years of V/STOL flight testing** R M Gerdes (NASA Ames Research Center Moffett Field CA) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 3 21 7 refs

The X 14 V/STOL research aircraft made its first free hover flight as a proof of concept test bed on Feb 19 1957 With the exception of two subsequent modification periods (to X 14A and X 14B) this V/STOL workhorse has been on continuous flight test status as a research aircraft and flying classroom The paper presents some of the highlights of its memorable 24 year flight test career with special emphasis on projects which have contributed to V/STOL technology and on the test pilots who made it happen (Author)

A82 14928 **Ball Bartoe Jetwing flight tests** R D Kimberlin (Tennessee University Tullahoma TN) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 22 40

Design features and flight test results of the Jetwing aircraft are reported The Jetwing employs an upper surface blowing concept in that all engine air is ducted through the leading edge of the wing and ejected over the top surface of the wing through a slot nozzle to achieve supercirculation lift and STOL performance The nozzle extends over 70% of the wingspan A Coanda flap is mounted at the

trailing edge of the blown portion of the wing and a smaller wing is located over the slot nozzle in low speed flight to reduce installed thrust losses A test plane with a 21 75 ft wingspan powered by a single 2200 lb thrust engine has completed 137 test flights Test instrumentation is described and in flight performance with sawtooth climbs at over 55 knots airspeed yielded a lift coefficient of 3 5 and a blowing coefficient of 1 0 Takeoff and landing ground roll were less than 1000 ft keeping within design goals of a STOL aircraft suitable for aircraft carrier and short unimproved runway use D H K

A82 14929 Flight investigations of integrated descent rate control systems W D Thompson *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 41 53

Results of tests to determine the effectiveness of spoilers for enhancing aircraft landing control are reported Combining the spoiler with a throttle control formed a descent rate control which improved handling performance produced effective drag control and lift and moment coupling and expanded the approach airspeed window The landing ground distances increased from 600 to 1000 ft as the approach angles increased The spoiler control is viewed as a glide path control which establishes a linear relationship between rate of sink and throttle position Inexperienced pilots were able to achieve touch down accuracies comparable to those displayed by experienced pilots flying normal aircraft No hard landings were encountered during landing testing the higher approach speeds simplified landings in gusting conditions and braking during landing roll was reduced D H K

A82 14930 Progress report CH-47 modernization program J C O Connor (U S Army Aviation Research and Devel opment Command St Louis MO) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981, p 54 64

Progress toward improving the CH 47D sufficiently to fill the Army medium lift requirements through the year 2000 is reviewed The mandatory mission profile includes pick up of a 15 000 lb load at 4000 ft at 95 F ambient temperature climb 200 fpm for one minute cruise outbound for 30 nm and return with fuel reserves for 30 nm The CH 47D employs twin turbine engines tandem counter rotating blades and can transport troops cargo and weapons in day night visual and instrument conditions An adaptation of the Chinook the CH 47D has a 30 min oil out capability has passed through preliminary air evaluation tests and features an advanced flight control system which allows hands off flight Reliability availability and maintenance tests revealed no uncorrectable prob lems after 342 flight hours although blade coating may be necessitated by a sparkling phenomenon that occurs during night flights in sandy conditions D H K

A82-14931 USNTPS spin program J R Watkins (U S Navy Naval Air Test Center Patuxent River, MD) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 82 86

The Navy Test Pilot School spin program is described including test procedures for out of control flight and the aircraft employed The T 2C Buckeye and X 26A Frigate are the current training aircraft Students observe upright incipient oscillatory and nonoscil lating spin and recovery and are then required to perform similar maneuvers before practicing upright spins as command pilots Inverted spins are terminated at 1 5 g and parameters such as minimum entry altitude mandatory action altitudes and pre and post flight aircraft inspection are outlined A 30 min out of control flight program is discussed noting the presence of a chase plane to gather telemetry on rotation roll yaw, and pitch/angle rates, and on altitude loss (1000 ft/turn) D H K

A82 14932 The USAF Test Pilot School high angle of attack and spin training program M D Edmondson (USAF Test Pilot School Edwards AFB CA) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16, no 2 1981 p 87 91

The training program at the Air Force Test Pilot School is reviewed The course is conducted in academic flight training and reporting phases and high angle of attack and spin conditions are accentuated Students are exposed to in depth studies of aerodynam ic inertial gyroscopic and other forces and moments necessary for fully developed spin Flight training begins in sailplanes equipped with a tape recorder and a kneeboard and proceeds to an A 37B with a 42 channel pulse code modulated data acquisition system Spin missions are safety monitored by an instructor on TV provided by a radar tracking telescope Spin recoveries in the sailplane and T 37B are described including erect and inverted spins An A 7D vehicle is employed for high angle of attack training, noting the hazard of pilot disorientation during high energy departures and rapid angular attitude changes D H K

A82 14933 Navy spin evaluation of the A 7 airplane configured with automatic maneuvering flaps C L White and L E Parrish (U S Navy Naval Air Test Center, Patuxent River MD) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 92 107

Test results of Navy evaluation of automatic maneuvering flaps (AMF) on an A 7B aircraft are presented The spin characteristics, the effects of asymmetric drop tank loading on the spin character istics and the effects of nose up longitudinal trim on the A 7 departure recovery were examined The AMF are on both leading and trailing edges of the wings modifications to the A 7 necessitated by the use of AMF are listed along with instrumentation and flight test procedures AMF was found to enhance the departure spin and recovery handling characteristics The asymmetric fuel tank loading was destabilizing at high angles of attack but was negated by the presence of AMF Recommended departure procedures were deter mined as optimal recovery techniques and details of the flight test maneuvers for spin entry recovery and in asymmetric loading conditions are presented D H K

A82 14934 F/A 18A high angle of attack/spin testing I M Behel and W G McNamara (U S Navy Naval Air Test Center Patuxent River MD) *(Society of Experimental Test Pilots Sympo sium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 108 132

High angle of attack (AOA) and spin test flights for the F/A 18A aircraft are discussed noting that high spin resistance features of the control laws necessitated a second separate set of control laws for spin recovery Wind tunnel and model testing results are reviewed with the 16% model yielding more accurate perfor mance prediction than the 6% scale model The control laws scheduled the maneuvering flaps to increase departure and spin resistance with full flap extension an optimum configuration for AOA above 25 deg Instrument feedback for longitudinal stability is outlined and the logic mode for spin recovery is discussed Finally the pilot cues high AOA characteristics and spin and spin recovery characteristics defined during flight testing are examined and the benefits of spin recovery cockpit displays for rapid recovery in stressful situations are emphasized D H K

A82 14935 KC 10 flight test program W S Smith (Douglas Aircraft Co Long Beach CA) and B Hinds (USAF Edwards AFB CA) *(Society of Experimental Test Pilots Sym posium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 136 143

Test features and results of refueling interface with various aircraft with the KC 10 Advanced Tanker/Cargo Aircraft are report ed The program sought to define the performance characteristics and operational capabilities of a converted wide body commercial plane the DC 10 freighter as a military cargo and refueling plane Modifications for the refueling receptacle slipway bladder fuel tanks boom and hose-drogue refueling system are outlined along with instrumentation alterations The KC 10 can carry 356 065 lb of fuel or 85 tons of cargo Acceptable clearances for ground operations were demonstrated and damping of boom oscillations at high Mach numbers was achieved during tests refueling the C 5 Further tests with the B 52 A 10 F 16 F 4 F 15 A 7D and A 7K aircraft as receptors were successfully completed Twelve KC 10 aircraft will be

operated to extend the Air Force's worldwide deployment operations D H K

A82 14936 The all composite Lear Fan 2100 H G Beaird Jr (Lear Fan Corp Reno, NV) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 144 153

Design and performance features of the all composite Lear Fan 2100 aircraft are described The plane has two engines one tail mounted propeller and can climb at 1400 fpm with one engine out The structure is a graphite composite which results in a greater range than with aluminum due to lighter weight plus a longer lifetime due to higher durability The engines provide 850 shaft hp apiece and the metallic content in the oil is electronically monitored to remain within a wide safety margin Standard ailerons elevators and rudders are controlled through cables and pushrods The operational altitude is 41 000 ft at 435 mph with the cabin pressurized to 8000 ft use of one propeller eliminates the occurrence of asymmetric thrust conditions Overall simplicity reliability durability and safety were the guiding principles in the design of the aircraft Nominal operation is given as a Mach 0 65 speed and 31 000 ft altitude D H K

A82 14937 Acceptance testing of the Calspan variable stability Learjet W J Brooks J W Smolka (USAF Test Pilot School Edwards AFB CA) R M Norman (U S Navy Test Pilot School Patuxent River MD) and A E Schelhorn (Calspan Advanced Technology Center Buffalo NY) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 154 181

The variable stability system incorporated into a Learjet for use as a flying classroom for USAF and USN Test Pilot students is described Side by side cockpit seating an observer station a data station and the capability of flight in a three axis fly by wire mode are provided Various linear and nonlinear flight control system characteristics along with simulating prefilter effects and transport delay are incorporated in the controls a number of closed loop flight control system configurations are also included Components of the variable stability system are discussed noting the ability of the digitally controlled response feedback system to simulate control reactions of various aircraft in response to the student pilot s control actions when handling numerous aircraft dynamic configurations D H K

A82-14938 F 15 SAR G L Jennings and P Henry (McDonnell Aircraft Co St Louis MO) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 182 197

The evolution and capabilities of the F 15 synthetic aperture radar (SAR) as an aid to all weather interdiction capabilities are discussed The radar has eight components and a 384K memory with Doppler beam sharpened (DBS) and air to ground capability DBS involves cutting the radar beam into azimuth elements and a processing detection filter in each element range/azimuth resolution is 250 ft Design goals of 8 5 ft resolution involve the application of coherent processing which is the SAR The antenna senses a point on the ground for a predetermined period of time to produce the required synthetic aperture The 8 5 ft resolution SAR is currently operational for bombing target identification D H K

A82 14939 F/A 18 roll rate improvement program M J Tkach (McDonnell Aircraft Co St Louis MO) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16 no 2 1981 p 198-202

The roll rate improvements made during the F/A 18 Full Scale Development Program are reviewed Detection of low wing stiffness and high aerodynamic damping led to thickening the web and caps of the aft main spar and adding additional layers of composites to the skin aft of the main torque box Roll power was increased by extending the aileron span implementing differential edge flaps and increasing the differential tail authority Steady state roll at altitudes above 10 000 ft resulted Differential leading edge flaps were then added to prevent roll rate decay at lower altitudes A position stick will replace the current force stick to allow the F/A 18 to exceed the time-to bank requirements throughout the flight envelope D H K

A82 14940 AV-8B technical update Leading edge root extension development C A Plummer (McDonnell Douglas Corp, St Louis MO) *(Society of Experimental Test Pilots Symposium 25th Beverly Hills CA Sept 23 26 1981) Society of Experimental Test Pilots Technical Review* vol 16, no 2 1981 p 203 209

The effects of leading edge root extensions (LERX) on the instantaneous turn rate of the AV 8B aircraft are investigated The LERX was 5 5 ft long with an 11 ft span and an anhedral of 11 deg the planform comprised 7 5 sq ft/side, for a net gain of 15 sq ft a net weight of 150 lb and a shift of the center of gravity by 0 5% A total of forty four test flights carrying various weaponry configurations were conducted for data on the full flight envelope V/STOL cruise speed fuel efficiency maximum speed and dynamic stability and control were either unchanged or beneficially affected Buffet was reduced and instantaneous turn rate increased 21% although some decrease in longitudinal stability was noted A reduction of the all composite LERX to 4 2 ft/side lowered the turn rate increase 17% and kept the decrease in longitudinal stability to 2 5% which was acceptable D H K

A82 14946 † Safety of helicopters in flight (Bezopasnost poletov vertoletov) A M Volodko Moscow Izdatel stvo Transport 1981 224 p 21 refs In Russian

Safety related aspects of single rotor and coaxial helicopter operation are summarized with reference to aerodynamics flight dynamics, aeroelasticity vibrations and dynamic strength of structures performance of gas turbine engines and automatic control systems reliability crew performance and aeronautical meteorology The physical meaning of the principal flight restrictions contained in the flight manual is examined and possible errors are discussed Finally special situations involving complicated flight conditions and equipment failure are discussed along with recommendations on flight safety and accident investigation V L

A82 14952 U S Navy life support development trends D N DeSimone (U S Naval Material Command Naval Air Development Center Warminster PA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 1 4

The methodology and trends in navy aircrew life support research and development are reviewed Life support and survival gear are complementary between all services where flight safety escape or survival functions may overlap The hardware and procedural use development of any component undergoes exploratory development advanced development and advance engineering development before deployment Research and development activities are initiated to respond to high accident rates crew member functional constraints POW reports and updated logistics systems Programs currently exploring improvements in environmental and escape systems fixed seating parachutes with no maintenance protective clothing survival and rescue and physiological standards for equipment are described M S K

A82 14953 * Emergency in flight egress for general aviation aircraft L J Bement (NASA Langley Research Center Hampton VA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 16 24

A NASA program for development of an inflight egress system for the left (pilot) door of general aviation aircraft is described The pyrotechnic release door was felt to be necessary because of pilot difficulty in reaching the right door when subjected to spin/stall centrifugal effects A flexible linear shaped charged of hexanitrostibene II and a lanyard actuated detonator are discussed along with mock up tests and instrumentation The egress system was designed for minimum structural impact mimimum pilot initiation procedures low weight and no egress interference and to provide sufficient force to blow off the door have low required maintenance and high reliability Results of 68 tests are reviewed noting the inclusion of a screen to keep glass fragments from spraying the cabin

Certification was achieved and uses in the F 111 and B 1 aircraft are noted M S K

A82 14954 * Operational evaluation of thunderstorm penetration test flights during project Storm Hazards 80 G L Keyser Jr P L Deal B D Fisher and N L Crabill (NASA Langley Research Center Hampton VA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 44 49

The National Aeronautics and Space Administration is conducting a research project called Storm Hazards 80 in order to study the prediction detectability and avoidance of the hazards of severe storms for aircraft operations The project using a highly instrumented NASA F 106B airplane to penetrate thunderstorms gathered and correlated data from both airborne and ground based instrumentation The objectives of this project are to determine the effects of lightning on the design and operation of aircraft composite structures and digital electronic systems The data will be used to determine the correlation of lightning hazards with other severe storm hazards such as heavy precipitation hail turbulence and wind-shear in order to develop an initial data base for use in design and avoidance The NASA F 106B was equipped with a weather radar stormscope lightning measurement instrumentation and air sampling equipment This paper will focus on the operational aspects of thunderstorm penetrations and the pilot techniques used to avoid the extremely hazardous portions of the storm such as the tornadoes and hail It will deal with the effects of the storm elements on the aircraft hardware avionics and the crew (Author)

A82 14955 Testing of the SJU 5A ejection seat for the F/A 18 /HORNET/ aircraft. T A Pavlik (U S Naval Air Systems Command Washington DC) and B Macnab (Martin Baker Aircraft Co Ltd Uxbridge Middx England) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 62 65

Results of developmental testing of the F/A 18 ejection seat are discussed Changes which were required to the basic configuration MK 10 seat included standard U S materials and processes environmental sealing of the mechanical devices redundancy of critical components single point safety handling incorporation of a navy seat kit oxygen and restraint system and incorporation of parachute water pockets Difficulties encountered due to the intercontinental distribution of production and testing sites are outlined and the parachute pyrotechnic device and survival kit are considered noting that testing comprised 14 ejections at speed from 0 600 knots The seat is now standard equipment on the F/A 18 M S K

A82 14956 Rescue at sea R G Eberhardt (U S Naval Weapons Center Parachute Systems Dept China Lake CA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 66 67

The Sea Water Activated Release System (SEAWARS) Program has the objective of reducing the number of aircrew member drownings that occur after a successful ejection and parachute descent into the ocean This paper addresses the historical evolution and development of the SEAWARS Program a brief overview of the system requirements preliminary Navy evaluation and current program status (Author)

A82 14958 'Little people problem /MA 2 torso harness/ V M Voge (U S Navy Naval Safety Center Norfolk VA) and H Pheeny (U S Naval Weapons Center China Lake CA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 76 79

Changes necessary to the MA 2 torso harness to accommodate use by smaller people notably females are described Measurements of flying personnel weighing less than 140 lb and shorter than 66 in resulted in a decision to keep the between K fitting distance at a minimum of 7 5 in which serves as a disqualification level An adjustable cinch strap has been added to the leg straps to compensate for people who are big enough yet experience difficulties with proper fitting Best fit requirements are presented noting that people who cannot be fit with a standard harness are candidates for custom fit harnesses Research into a nylon system with greater negative and lateral g restraint features is indicated M S K

A82 14960 Automatic parachute releasers for premeditated parachuting E Puskas (Para Flite, Inc Pennsauken NJ) In Survival and Flight Equipment Association, Annual Symposium, 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981, p 84 86

This paper is presented to inform members of the organization of the state of the art of Automatic Parachute Opener design, specifically the design of those used for premeditated parachuting This presentation covers the history the philosophy used in establishing design parameters, the technical differences in design dictated by specific applications the description and the differences in technology of the two primary design approaches currently in use current trends in utilization and direction that development of these devices will take in the foreseeable future (Author)

A82 14961 The history of the development of the GQ aeroconical parachute 1971 1980 A J Harrison (GQ Defence Equipment Ltd Woking Surrey England) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 93 96

Development and testing of the GQ aeroconical parachute, which is used to all variants of the MK 10 ejection seat, are reviewed The chute has a 36 in diameter vent equalling 18% of the flying diameter Two 11 7 sq ft panels positioned to the rear of the canopy at a 45 deg angle from the axis of symmetry allow a positive forward gliding component Details of the structural materials are presented and 55 medium/high speed trial drop tests are described A 20 3 ft/sec rate of descent is provided by the chute a rate which is not necessarily affected by torn seams Results of ejection seat tests are provided noting functional success at Mach 0 98 at 14 000 ft with a maximum deceleration of 26 6 g The chute inflates within 1 22 sec deployment occurs at 64 ft/sec and water pockets are included in the design to collapse the chute within 5 sec of a water landing M S K

A82 14963 A new safety harness for mobile aircrew D C Reader (USAF School of Aerospace Medicine Brooks AFB TX) In Survival and Flight Equipment Association Annual Symposium, 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 106 109

A safety harness for mobile crewmembers in both fixed and rotary winged aircraft has been designed It consists of a self tightening assembly of straps attached to a life preserver which is attached to an aircraft strong point by a strap with length adjustment The safety harness has been assessed for comfort compatibility with other items of aircrew equipment strength in suspension and drop tests and is now recommended for service trial (Author)

A82 14965 Further test results of parachutes with automatic inflation modulation /A I M/ D B Webb (Irvin Industries Canada Ltd Fort Erie Ontario Canada) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 116 123

An automatic inflation modulation canopy for the next generation of ejector seats is described The parachute features the use of unidirectional Kevlar stretch fabric in the crown area of the canopy and an auxiliary parachute inside the main canopy mouth The intent is to reduce the overall recovery flight path distance with a lower peak opening force A network of reefing lines are organized to be kept from tangling by a central marquisette which is held at a fixed point in the center of the canopy by a positioning line connected to the center point of the canopy Whirl tower overinflation and descent control and deployment tests results are reported and a 29 6 ft diam parachute was shown to display overinflation control

steady state stability and consistency of inflation timing at speeds up to 275 knots at 16 000 ft M S K

A82 14966 A look at the Hoffman Triangular parachute The first successful glidable parachute D Gold (U S Naval Weapons Center Parachute Systems Dept China Lake CA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association, 1981 p 124 131

The development of the Hoffman Triangular parachute is described Several designs were considered and a cloverleaf configura tion with a 25 ft canopy was chosen A short skirt opposite a lineless tail allowed for an increase in the glide velocity of the canopy The pilot parachute also featured four vanes, a springless elastic container flap system to throw the chute away from the jumper and rubber bands to retain bighted suspension lines in the container The company that produced the parachute failed in business but the use of the rubber bands to retain the suspension lines became a standard feature of parachute containers M S K

A82 14972 Evaluation of a selected group of anti exposure garment configurations for their effects on the operational performance and survival of Naval aircrewmen S M Reeps D C Johanson and L J SantaMaria (U S Naval Material Command Naval Air Development Center Warminster PA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA, October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 183-191

A82 14974 Test and evaluation of improved aircrew re straint systems G T Singley III (U S Army Applied Technology Laboratory Fort Eustis VA) In Survival and Flight Equipment Association Annual Symposium, 18th San Diego CA October 12 16, 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 196 201 7 refs

U S Army aviation accident data shows that a majority of all injuries in attack helicopters could have been avoided if these aircraft had been equipped with crashworthy seat and restraint systems The compactness of the cockpit and the close proximity of mission equipment to the aircrew in attack and scout helicopters pose serious crash impact hazards Although not desirable from a crashworthiness standpoint operational considerations may dictate that mission equipment and structure be located within the occupant s crash impact motion envelope Given this situation it is critical to the occupant's crash impact survival chances that he be provided with a restraint system that minimizes his crash impact motion envelope particularly for his head The cockpit can be delethalized further when the improved restraint is complemented by padding potential strike surfaces in the cockpit making contact surfaces frangible and providing weapon system sights with frangibility telescoping and/or swingaway features This paper presents the results of an effort to test and compare the potential of several aircrew restraint systems to reduce the crash impact motion envelope of helicopter aircrewmen (Author)

A82 14975 Design of a crashworthy crew seat for the Boeing Vertol Chinook helicopter R F Campbell (Boeing Vertol Co Philadelphia PA) In Survival and Flight Equipment Associa tion Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 202 208

The design and test results of a crashworthy seat for the Chinook are presented Requirements for the seat included the ability to withstand a crash pulse of 30 g peak with a 50 fps velocity change and a vertical pulse of 48 g peak with a 42 fps velocity change based on a 0 065 sec pulse duration An armored bucket capable of protecting against a 30 cal projectile at 100 m was fabricated and three adjustable attenuator wires were added each sized to stroke at 600 lb over the seven in minimum stroking distance Features of the support structure the armored Kevlar bucket cushions restraints and testing procedures are outlined and current work on a self adjusting infinitely variable attenuator is indicated as a means to provide a constant inertia system M S K

A82 14976 Crashworthy military passenger seat develop ment. L Domzalski (U S Naval Material Command Naval Air Development Center Warminster PA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 209 215 11 refs

The performance criteria design concepts and test results for Navy crashworthy fixed wing aircraft passenger seats are reviewed Noting the enhanced crashworthiness of a rearward facing seat crash pulses with 30 deg pitch 19 deg roll and 30 deg yaw are mentioned as dynamic test criteria Ultimate static loading factors are defined and the lack of velocity change data from accident investigation reports is stressed as a deficiency A two passenger seating arrange ment with a total weight of 55 lb was chosen and included a double harness/lap belt configuration A steel bench able to withstand a velocity change of 64 fps while supporting two 250 lb passengers resulted with a maximum energy absorber force setting of 3000 lb on the leg struts Tests of the seat showed a resistance to up to 8 g force (4000 lb) about half the requirements and indicate a need to redesign to comply with rearward and lateral static load/deflection criteria M S K

A82 14977 HASEP Survival from crashed Navy helicop ters J Micciche (U S Naval Material Command Naval Air Develop ment Center Warminster PA) and J J Iatesta (Sanders and Thomas Inc Pottstown PA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park, CA Survival and Flight Equipment Association 1981 p 216 220 6 refs

The Navy s Helicopter Aircrew Survivability Program (HASEP) was originally planned to enhance the inflight recovery and survival capability for helicopter aircrewmen HASEP more recently has been directed to eliminate inflight recovery It focuses on the survival technologies with high near term payoff The currently active technologies are discussed taking into account the H 46 helicopter emergency flotation system the helicopter emergency egress lighting system a comparison of underwater helicopter escape lights the H 46 crashworthy cargo restraint a crashworthy troop seat integra tion for H 46 and an automatic life raft system G R

A82 14978 Analysis of escape systems at 687 KEAS D T Ther and R F Yurczyk (Boeing Military Airplane Co Seattle WA) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 221 225 Contract No F33615 79-C 3406

Attention is given to the Advance Ejection Seat program which was concerned with the selection of deployable aerodynamic devices to reduce the acceleration levels of an ejection seat The object of this program was to find a configuration which could operate at a dynamic pressure of 1600 psf and satisfy the acceleration require ment of MIL S 94798 Estimated aerodynamic coefficients were used in a three degree of freedom simulation to select a set of configurations which seemed sufficiently promising to be analyzed in a wind tunnel Refined aerodynamic coefficients were obtained from wind tunnel tests and these data were used in the simulation to select the final configuration The simulations show that improvement of seat acceleration performance is a complex problem which is not solvable by simply reducing drag It was found that control of seat attitude and stability is essential to good acceleration performance G R

A82 14979 Wind tunnel tests of ejection seat for high dynamic pressure escape J O Bull and R F Yurczyk (Boeing Military Airplane Co Seattle WA) In Survival and Flight Equip ment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 226 230 USAF supported research

In connection with the employment of the currently used multimode rapidly sequenced ejection system it was found that a higher injury and fatality rate resulted from more ejections at high speed A program was initiated to evaluate advanced ejection seat concepts for escape in the high dynamic pressure regime (1600 PSF or 687 KEAS) A description is presented of the wind tunnel test

phase of the program Wind tunnel data were obtained on 12 high Q ejection seat configuration variations Complete six component data were obtained throughout an angle of attack angle of yaw and Mach number range to obtain a basis for conducting six degree of freedom computer simulations of ejection seat stability trajectory and performance characteristics Based on a preliminary review of the data a seat with 18 deg boom and stabilizer and a seat with 18 deg boom and stabilizer plus a flow diverter appear to be the most viable candidates for the high Q ejection seat G R

A82 14980 Performance assessment of the ACES II ejection seat-A 10 configuration E O Roberts (USAF Flight Dynamics Laboratory Wright Patterson AFB OH) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 231 234

A brief overview is presented of a performance analysis of the ACES II ejection seat for the A 10 aircraft The analysis is conducted with the aid of a computer simulation program called SAFEST which stands for Simulation and Analysis of In Flight Escape System Techniques A comparison between track test results and the computer simulation has shown very good simulation This correlation indicates that complete simulation has now been realized The obtained results can be used to design and develop new and improved escape systems at lower costs The analysis proves the value of computer simulation in the design and the evaluation of ejection seat systems G R

A82 14981 Post ejection survival B Limbrey (Martin Baker Aircraft Co Ltd Uxbridge Middx England) In Survival and Flight Equipment Association Annual Symposium 18th, San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 235 238

The causes of fatalities occurring during escapes involving ejection seats are examined It is found that 62% of fatalities were due to striking the ground before the parachute had time to develop The second principal cause of fatality is drowning or lost at sea presumed drowned (25%) The remaining causes of fatality are many and varied and each makes up only a very small proportion of all fatalities Approaches are discussed for aiding the aviator who descends on his parachute into the sea Attention is given to fatalities occurring in the cases of a single point parachute release and a multiple parachute release It was found that the number of fatalities for single point releases was much smaller than for multiple releases G R

A82 14982 Terrain actuated deployment system J K Seitler (ARO Corp Buffalo NY) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 239 244

A description is presented of a radar altimeter which was developed to automatically detect when an ejectee after man seat separation and a five second delay reaches a height of 500 through 100 feet above the terrain The radar altimeter then triggers the deployment of the survival kit and subsequent inflation of the life raft contained in the survival kit The radar altimeter uses a solid state transmitter and a tuned RF receiver at the transmitter frequency Sufficient sensitivity and selectivity is assured by RF amplification and filtering The video processing and timing circuits process received terrain echos only if they exceed the threshold level and are associated with heights of from 100 to 500 feet G R

A82-14983 A system safety program for aircraft production and deployment. L E Rackley (General Dynamics Corp Fort Worth TX) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 245 249

Changes are sometimes made to an aircraft without adequate consideration of system safety or other specialty engineering aspects An investigation is conducted concerning the implementation of suitable approaches for avoiding such a neglect with respect to vital system characteristics It is found to be important that system safety is also considered during design changes made after fleet deployment System safety considerations should have a significant effect on the decision making process of implementing the change In order to follow the given recommendations however it will be necessary to establish an adequate system safety data base during the development phase and maintain it through the production phase and as long after fleet deployment as necessary G R

A82 14984 A ballistic design model for initiators for aircraft personnel escape systems. B E Paul (SCOT Inc Downers Grove IL) In Survival and Flight Equipment Association Annual Symposium 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA Survival and Flight Equipment Association 1981 p 250 252

In a review of the T 38 interseat sequencing system it was found that more information was needed regarding the pressure history in an initiator system In response to this observation a ballistic model was developed which characterizes the entire pressure space time function in the initiator The model was applied to two diverse initiators The correlation was found to be quite good The model was also applied to conditions which yielded rather high in tube peak pressures and predicted a similar occurrence It was then used to establish a method for improvement of this condition It appears that the model can be efficiently utilized for the development of any new initiator system or the modification of current systems The model is capable of handling layouts with multiple branches and/or multiple initiator sources G R

A82 14985 Analytical and experimental characterization of the JAU 14/A cartridge actuated initiator for use in aircrew escape system performance evaluation A M Varney R J Brandstadt J D Martino (Applied Combustion Technology Inc Orlando FL) and J L Hinds (U S Navy Naval Ordnance Station Indian Head, MD) In Survival and Flight Equipment Association Annual Symposium, 18th San Diego CA October 12 16 1980 Proceedings Canoga Park CA, Survival and Flight Equipment Association 1981 p 253 255

A82 14998 † The technology of sheet metal stamping in the production of aircraft /2nd revised and enlarged edition/ (Tekhnologiia zagotovitel no shtampovochnykh rabot v proizvodstve samoletov /2nd revised and enlarged edition/) M N Gorbunov Moscow Izdatel stvo Mashinostroenie 1981 224 p 43 refs In Russian

The general characteristics of sheet metal stamping operations are discussed followed by a detailed description of the individual stamping procedures This includes the location and spacing of blanks and means of improving the quality of the cutting edge The bending method is then described including a discussion of the stress strain state the minimal radius of bending bending with tangential tension and compression and bending with radial compression The flanging and expansion processes are discussed as is stretch wrap forming molding and die forging Attention is also given to the stamping of more complicated shapes and to other methods of stamping in the production of aircraft J F

A82-15311 Prediction and performance of radome-covered reflector antennas P J B Clarricoats C G Parini and M S A S Rizk (Queen Mary College London, England) *(International Union of Radio Science Symposium on Electromagnetic Waves 10th Technische Universitat Munchen Munich West Germany Aug 26 29, 1980) Radio Science* vol 16, Nov Dec 1981 p 1105 1110 Research supported by the Science Research Council

The return loss (reflection coefficient) of a paraboloidal radome is predicted by a physical optics method based on the power coupling theorem An asymptotic form of the reflection coefficient is found to be very accurate and consistent with a simple geometric optics interpretation A method to reduce the return loss is investigated using a hemispherical iris loaded sandwich section of the center of the radome and an improvement of approximately 5 dB is observed over a useful frequency bandwidth Contributions of the radome to the radiation pattern of the antenna are identified and those near to boresight are predicted D L G

A82 15468 # A criterion for determining the causes of wind shear at Punta Raisi Airport, on the basis of statistical data from barograph records (Ricerca di un criterio per la determinazione delle

cause del wind shear verificatosi nell aeroporto di Punta Raisi attraverso i dati statistici rilevati da registrazioni barografiche) O Cosentino (Aeronautica Oblitare Servizio Meteorologico Rome Italy) and G Ferlazzo (Palermo Universita Palermo Italy) *Rivista di Meteorologia Aeronautica* vol 41 Apr June 1981 p 127 135 7 refs In Italian

A statistical analysis has been conducted on pressure jumps appearing in the barograph records of Punta Raisi airport which are compared with such corresponding meteorological parameters as wind temperature and humidity in order to determine the synoptic local and orographic causes of the phenomena Attention is given the characteristics and causes of wind shear in the geographical context of the airport and it is concluded that prefrontal or frontal pressure variations accompanied by local elevation phenomena with cumulus clouding result in horizontal wind shear over the area in which barometric jumps are experienced O C

A82 15482 † **Study of the load carrying capacity of aviation gas turbine engine impellers under low cycle loading at normal and high temperatures (Issledovanie nesushchei sposobnosti rabochikh koles kompressorov aviatsionnykh GTD pri malotsiklovom nagruzhenii v usloviiakh normal noi i povyshennykh temperatur)** V G Bazhenov A D Baliuk B G Reznik and V P Gontarovskii (Kievskii Politekhnicheskii Institut Zhitomir Ukrainian SSR) *Problemy Prochnosti* Nov 1981 p 45 48 In Russian

A rotor was designed for testing the impeller of gas turbine engines under low cycle loading considering the force interaction of neighboring stages The stress strain state of a disk of an impeller was calculated by means of an algorithm based on the finite element method and the theory of small elastoplastic deformations The load carrying capacity of the impeller is estimated under conditions approximating those found in a real operational environment J F

A82 15596 **Direct free flight analysis of aircraft dynamics at high angles of attack** M E Beyers (South African Council for Scientific and Industrial Research National Institute for Aeronautics and Systems Technology Pretoria Republic of South Africa) *Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers Journal* vol 2 no 1 1981 p 17 28 26 refs

Concepts are examined for the analysis of high maneuverability aircraft dynamics on the basis of gross flight dynamic effects observed in wind tunnel free flight experiments Experimental and analytical techniques developed to study the generic nonoscillatory free flight motion of flight vehicles trimmed at significant angles of attack are reviewed The feasibility of aircraft model free flight tests is demonstrated on the basis of simulations and trajectory validation schemes are proposed for the corroboration of free flight and captive model dynamic data Finally the rationale underlying the utilization of data gathered in captive and free model dynamic stability tests of high performance aircraft is examined in the context of design objectives of high maneuverability and good flying qualities (Author)

A82 15597 **A matter of seconds A critical account of three notable air disasters /5th Major Miller Memorial Lecture/** C S Margo *Aeronautical Society of South Africa and South African Institute of Aeronautical Engineers Journal* vol 2 no 1 1981 p 30 35

Three aircraft accidents are analyzed for causes and remedies A DC 10 crash of May 25 1979 comprised the loss of an engine on take off and subsequent loss of control leading to grounding 31 sec later Continued unsymmetric repair maintenance and replacement of the engines from one side or the other had led to structural failure and loss of control occurred in the absence of stall indication and power from the side of the lost engine An increase of speed is judged to have been capable of preventing the crash Although little evidence was left after the accident that killed Dag Hammarskjold, an evaluation is given that the pilot s knowledge of the height above sea level was uncertain Finally a crash of a Boeing 707 on April 20 1968 is determined to have happened because of premature transition from take off to climb power It is noted that the pilot had had a total of one hour s experience with that particular version of the 707 M S K

A82 15599 **Computer image generation for flight simulation** B J Schachter (Westinghouse Defense and Electronics Systems Center Baltimore MD) *IEEE Computer Graphics and Applications* vol 1 Oct 1981 p 29 32 34 38 40-46 (17 ff) 130 refs

The features and capabilities of computer image generation for producing effective imagery for flight simulation are explored CRT operational parameters designed to meet necessary realism for human visual interaction are outlined noting the eye s tendency to concentrate on one small area of resolution at a time Four currently available systems are examined along with control logic the NASA three view space flight simulator and block diagrams of information routing VLSI processors holographic image displays interactive computer graphics and optical disks are considered for advanced simulator systems M S K

A82 15606 **Experimental investigation of total pressure loss and airflow distribution for gas turbine combustors** Z M Fan and Z F Chao (China Gas Turbine Research Institute People s Republic of China) *(Journal of Engineering Thermophysics* vol 1 May 1980 p 185 194) *Engineering Thermophysics in China* vol 1 Apr June 1980 p 207 217 Translation

Results of theoretical and experimental investigations are presented to demonstrate the feasibility of a solution for certain one dimensional simultaneous equations The current flow drag method and the hole blanketing experimental method are shown to have difficulties and a simple technique of calculation using the mean flow coefficient is provided Results of calculations in accordance with the one dimensional flow simultaneous solution are compared with those obtained with the mean flow coefficient method and experimental results showing good agreement D L G

A82 15625 **Large terminal maneuvering areas Operational problems Possible development of solutions (Les grandes zones de manoeuvre terminale Problèmes operationnels Evolution possible des solutions)** J L Garnier (Direction de la Navigation Aerienne, Paris, France) *(Organisation Europeenne pour l Equipement Electronique de la Navigation Aérienne Forum Technique, Rome Italy May 15 1981) Navigation* (Paris) vol 29, Oct 1981 p 443 451 In French

The operational problems associated with large terminal maneuvering areas (TMAs) are examined and means by which these problems may be alleviated by the use of expected technological advances are considered The TMA is defined as the region of space occupied by flights departing from or having a destination in the area concerned within which aircraft are climbing towards or descending from their cruise levels Means currently in use for the management of air traffic within a TMA such as that of Paris are indicated Current problems arising in the use of TMAs are attributed to the phenomena of high traffic levels and the necessity of standbys in the presence of the competing priorities of large capacity and user economics The possible contributions of the DABS selective addressing secondary radar system, MLS and precision DME to the resolution of these problems are examined, and it is concluded that while all these techniques have their place in the TMAs of the future, additional measures in the areas of onboard navigation equipment, automated ground assistance and traffic control systems are required A L W

A82 15655 † **Current aerial cameras (Sovremennye aerofotoapparaty)** V G Afremov and V B Il in *Geodeziia i Kartografiia* Oct 1981 p 40-42 6 refs In Russian

The paper considers the development and operation of the TE and TES aerial cameras having focal distances of 350 100 70 and 50 mm and FOV angles of 40 103 120, and 136 5 deg respectively for 18 x 18 cm frames The basic technical characteristics and some applications of these cameras are presented B J

A82 15721 † **Quality optimization and unification of aviation gasolines (Optimizatsiia kachestva i unifikatsiia aviatsionnykh benzinov)** V E Emel ianov K A Demidenko and B A Englin (Vsesoiuznyi Nauchno Issledovatel skii Institut Neftianoi Promyshlennosti, Moscow USSR) *Khimiia i Tekhnologiia Topliv i Masel* no 11 1981 p 18 19 In Russian

The introduction of a new process for the production of

aviation gasolines based on reformed gasoline has made it possible to optimize the quality of aviation gasolines with respect to their chemical stability tar content iodine number and the content of an antioxidizer The principal properties of gasolines B 91/115 B 95/130, and B 100/130 are briefly reviewed It is proposed to replace the aviation gasolines currently in use with a single gasoline type B 91/115 with an octane number of not less than 95 V L

A82 15723 † **Optimization of requirements on the pitting-prevention properties of turbojet engine oils (Optimizatsiia trebovanii k protivopittingovym svoistvam masel dlia turboreaktivnykh dvigatelei)** B S Gutenev A V Vilenkin G T Novosartov V G Gorodetskii and B F Kirdakov *Khimiia i Tekhnologiia Topliv i Masel* no 11 1981 p 30 31 5 refs In Russian

Analysis of the operating conditions of bearings in turbojet engines shows that the probability of trouble free bearing service is reduced with increasing temperatures and loads In order to increase the service life of turbojet engine bearings a study has been carried out with the aim of improving the pitting prevention properties of MS 8p oil This objective has been achieved by substituting a chlorine containing additive for a phosphorus containing additive V L

A82 15724 † **Efficient use of working fluids in aviation hydraulic systems (Ratsional noe primenenie rabochikh zhidkostei v aviatsionnykh gidravlicheskikh sistemakh)** B G Bedrik V S Ugriumov and A F Iakovleva *Khimiia i Tekhnologiia Topliv i Masel* no 11 1981 p 33 35 In Russian

Changes in the quality of working fluids in the hydraulic equipment of aircraft in the process of equipment operation are analyzed It is shown that by scheduling fluid replacement with allowance for the actual condition of the fluid it would be possible to reduce fluid consumption by 1 5 2 times without a tradeoff in equipment reliability V L

A82 15748 A VHF homing system with VHF radio telephony for area representative strip-survey flights conducted, as part of combined forest inventories, with light aircraft carrying 70 mm and 35 mm cameras (Ein VHF Homing System mit VHF Sprechfunk fur flachenreprasentative Streifenbefliegungen mit 70 mm und 35 mm Kameras von leichten Flugzeugen im Rahmen kombinierter Waldinventuren) B Rhody (Bundesforschungsanstalt fur Forst und Holzwirtschaft Hamburg West Germany) *Bild messung und Luftbildwesen* vol 49 Nov 1 1981, p 199 203 In German

A82-15816 Computer animated predictive displays for microwave landing approaches S N Roscoe (New Mexico State University Las Cruces NM) and R S Jensen (Ohio State University Columbus OH) *IEEE Transactions on Systems Man and Cybernetics* vol SMC 11 Nov 1981 p 760 765 55 refs

It is shown that a safe, orderly and economical flow of air traffic at congested metropolitan airports can be ensured by microwave radio guidance systems By furnishing aircraft position in three dimensions these terminal navigation aids potentially allow steeply curved landing approaches that will facilitate unprecedented noise abatement procedures large fuel savings and precisely timed arrivals at airport runways To implement such complex flight procedures a combination of semiautomatic computer assisted air plane guidance and control and radically different flight displays will be required if pilots are to monitor such maneuvers confidently and execute them manually when necessary Results of a simulator investigation involving visual guidance and flight path prediction embedded in computer animated contact analog displays show that pilots can reliably execute computer programmed curved approaches to airport runways with the required precision in the face of severe wind shears C R

A82 15823 The influence of wind shear and vertical winds on takeoffs and go-arounds R Konig and P Krauspe (Braunschweig Technische Universitat Braunschweig, West Germany) *Airport Forum* vol 11 Oct 1981 p 43-46 8 refs

The effects of wind shear and vertical winds on aircraft takeoffs and go arounds is discussed It is noted that with the advent of a more modern autopilot generation and advanced wind shear warning indicators landing accidents due to wind shear will be avoidable Hazards posed by low velocity downdrafts and wind shear in the lee of a large-surface obstacle are also considered with reference to studies made a a German airport and with simulators Operational considerations of wind shear are assessed S C S

A82 15824 'In situ' composites for jet propulsion and stationary gas turbine applications W Bunk (Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt Institut fur Werkstoff Forschung Cologne Aachen Rheinisch Westfalische Technische Hochschule Aachen West Germany) and P R Sahm (Aachen, Rheinisch Westfalische Technische Hochschule Aachen West Germany) *Zeitschrift fur Werkstofftechnik* vol 12, Oct 1981 p 345 359 25 refs Research supported by the Bundesministerium fur Forschung und Technologie

Examples of reinforced superalloys for high temperature applications in jet engines are reported The phase stability of microstructures is tested with a high thermal gradient device and first engine tests of directionally solidified Co Cr7C3 eutectic alloy are reported Properties such as creep behavior, fatigue, and oxidation resistance are measured and compared with corresponding data for both conventionally and directionally cast Ni base superalloy IN 738 First engine tests of 18 000 hrs with unalloyed Co Cr7C3 vanes indicate the importance of a fully eutectic microstructure and stability against carbide transformations D L G

A82 15827 Rapid elliptic solvers R W Hockney (Reading, University Reading Berks, England) In Numerical methods in applied fluid dynamics London and New York, Academic Press 1980 p 1 48 37 refs

Rapid direct methods for the solution of certain classes of elliptic partial differential equations (pde) have been in use for over ten years Such methods are based on Fourier analysis, cyclic reduction and optimal combinations of the two To classify as a Rapid Elliptic Solver (RES) the algorithm must solve the elliptic equation of an (n x n) mesh in a number of floating-point arithmetic operations which corresponds approximately to the source of n The methods are also characterized by the minimum use of storage A number of different RES algorithms for the solution of pde's are considered taking into account questions concerning the choice of algorithm the method of Fourier Analysis and Cyclic Reduction (FACR) the cyclic reduction process marching methods and a comparison of programs Attention is also given to nonseparable equations and the N body problem G R

A82 15835 Remarks on the calculation of transonic potential flow by a finite volume method A Jameson (New York University New York NY) In Numerical methods in applied fluid dynamics London and New York Academic Press, 1980 p 363 386 18 refs Contract No N00014 77 C-0032

The development of a finite volume method for the numerical calculation of transonic flow is considered It is assumed that the flow is irrotational so that the velocity can be represented as the gradient of a potential Essentially this limits the application of the method to flows containing fairly weak shock waves for which the Mach number of the normal component of the velocity ahead of the shock is not substantially greater than 1 3 since shock waves are to be modelled by isentropic jumps The formulation of the equations is discussed taking into account the case of a wing or wing body combination in a uniform stream The discrete approximation to the equations is developed by using a subdivision of the domain into distorted cubic cells The developed procedure is applied to the study of swept wings The results of the calculations encourage confidence in the usefulness of the potential flow model for engineering predictions G R

A82 15845 # **Robust flight control A design example** S N Franklin (Systems Control Technology Inc Palo Alto CA) and J Ackermann (Deutsche Forschungs und Versuchsanstalt fur Luft- und Raumfahrt, Institut fur Dynamik der Flugsysteme Oberpfaffenhofen, West Germany) *Journal of Guidance and Control* vol 4 Nov Dec 1981, p 597 605 6 refs Research supported by the

Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt Grant No AF AFOSR 78 3633 Contract No N00014 79 C 0424

A novel parameter space method is used as a tool for the design of a robust stabilization system for the short period longitudinal mode of a fighter aircraft The example is an F 4E with additional horizontal canards Robustness is achieved in the sense that military specifications for damping and natural frequency are satisfied by a constant controller in spite of perturbations The perturbations are changing flight conditions and undetected sensor failures The resulting controller structure requires two gyros and one accelero meter The system including actuator dynamics and feedback dynamics is of sixth order and in the design, four free controller parameters have been assumed Practical considerations are taken into account such as bandwidth limitation below structural vibration frequencies actuator limitations, and relaxed emergency specifi cations in failure situations (Author)

A82 15846 † **Airplane performance sensitivities to lateral and vertical profiles** J C Wauer J M H Bruckner (Rockwell International Corp Cedar Rapids IA) and C H Humphrey (United Air Lines Inc San Francisco CA) *Journal of Guidance and Control* vol 4 Nov Dec 1981 p 606 613 11 refs

Airplane performance sensitivity to the choice of lateral and vertical profiles is studied based on data recorded on in service flights of a 727 200 airplane equipped with JT9D 7 engines Lateral profile performance sensitivity is based on analysis of flight technical or guidance error and on varying degrees of direct flight clearance Vertical analysis is based on an aerodynamic simulation of the recorded flights Sensitivity to the choice of vertical profile is studied by simulating the actual profile that was flown two perfectly flown constant IAS/Mach profiles and minimum cost and minimum fuel optimum profiles Some of the practical considerations in imple menting the real time optimum profile algorithms and some of the difficulties encountered with the optimum profile computations are discussed Predicted fuel and time savings are related to the air traffic control (ATC) environment experienced by the airlines to obtain net savings predictions with varying degrees of ATC restriction (Author)

A82 15847 * # **Experimental evaluation of a perspective tun nel display for three dimensional helicopter approaches** A J Grunwald (Technion Israel Institute of Technology Haifa Israel) J B Robertson and J J Hatfield (NASA Langley Research Center Flight Electronics Div Hampton VA) *Journal of Guidance and Control* vol 4 Nov Dec 1981 p 623 631 11 refs

A computer generated perspective tunnel display for a steep and strongly curved three dimensional helicopter approach is studied The necessary control variables for following a curved trajectory are analyzed the effectiveness of superimposed predictor symbology is investigated and a suitable predictor law is formulated The theoretical considerations are validated by an extensive fixed base simulator program The tunnel display with a superimposed predictor symbol is shown to outperform conventional type displays in its abilities to follow a curved trajectory in the presence of gust disturbances to enter the trajectory from an unknown position outside this trajectory as well as to monitor automatic approaches The feasibility of the tunnel display for operation in actual flight has been demonstrated in an exploratory flight test (Author)

A82 15864 **Mathematical programming in engineering design problems** H J Baier (Dornier System GmbH Friedrichshafen West Germany) In Numerical optimisation of dynamic systems Amsterdam, North Holland Publishing Co 1980 p 391-410 19 refs

The application of mathematical programming to engineering design problems is considered After the statement of the problem some real world applications are discussed and some comments on the impact of mathematical programming on the engineering design process are made Sequential unconstrained minimization technique, sequential linear programming and Lagrangian multiplier methods are presented as three important representatives of optimization algorithms in this field of application The discussion of some special features shows what can be undertaken to improve their relative performance Finally an assessment of these algorithms is made (Author)

A82 15918 # **High voltage/high power for airborne applica tions** F C Brockhurst (USAF Institute of Technology Wright Patterson AFB, OH) and M P Dougherty (USAF Aero Propulsion Laboratory Wright Patterson AFB OH) *IEEE Transactions on Aerospace and Electronic Systems* vol AES 17 Nov 1981 p 795-801 15 refs

Advancements made in technologies required for lightweight high voltage, high power airborne power systems are discussed Programs to reduce the weight of rotating machines transformers, switches, inverters and capacitors are described and some aspects in the use of these components in the design of lightweight systems are considered Interactive programs already developed allow the design er to analyze circuit performance and perform component and limited system design while additional programs are planned with emphasis on quick response ease of use, and versatility D L G

A82 15950 **CT7 GE attacks commuter turboprop mar ket** J Moxon *Flight International* vol 120 Nov 21 1981 p 1572 1575, 1576

A description is given of the design features and performance capabilities of the CT7 turboprop engine which is intended for commuter aircraft of the 30 35 seat class The 1700 shaft horse power engine employs a combined axial/centrifugal compressor to achieve a pressure ratio of 17 1 and turbine entry temperatures of over 1200 C Emphasis is put on the engine's maintainability which allows field changes of all modules with only a 12 piece standard tool kit It is claimed that the CT7 engine core is 30% more fuel efficient than the CT58 helicopter engine core which it is scheduled to replace The engine incorporates a centrifugal inlet separator that rejects 85 95% of all sand and dust The reliability of the CT7 is in part due to the development and operational experience accumulated with the T700 military turboshaft on which its design is based O C

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STAR ENTRIES

N82-12030 Air Force Inst of Tech , Wright-Patterson AFB, Ohio

THE NUMERICAL SOLUTION OF INCOMPRESSIBLE TURBULENT FLOW OVER AIRFOILS Ph.D Thesis

Harwood Allan Hegna 1981 168 p

Avail Univ Microfilms Order No 8119139

An algebraic eddy viscosity turbulence model based on Prandtl's mixing length theory was modified for separated adverse pressure gradient flows Finite difference methods for solving the inviscid stream function equation and the incompressible laminar Navier-Stokes equations were used A finite difference method for solving the Reynolds averaged incompressible turbulent two-dimensional Navier-Stokes equations were employed Solutions for a NACA 0012 airfoil at angles of attack varying from five to 11 5 degrees at a chord Reynolds number of 170 000 were obtained Velocity profiles near the airfoil surface and surface pressure distributions are presented and compared with experimental data Lift and drag coefficients agree well with experimental values Dissert Abstr

N82-12031 Arizona Univ , Tucson

SUBCRITICAL AND SUPERCRITICAL AIRFOILS FOR GIVEN PRESSURE DISTRIBUTION Ph.D. Thesis

Ahmed Abdelatif HassanEissa 1981 82 p

Avail Univ Microfilms Order No 8121930

An effective method, based on hodograph theory, was developed for the aerodynamic design of subcritical and shock-free supercritical airfoil sections In addition to the free-stream conditions, the input to the design procedure includes a prescription of the subsonic part of a target pressure distribution and, for supercritical airfoils, of a presumed stream function on the sonic line A computer program carries out a number of sequential steps that result in an airfoil with a pressure distribution close to that desired at little computational cost Thus, the airfoil designer can alter the input if design goals are not met and quickly produce another candidate airfoil This is aided by appropriate graphic display of the airfoil and its pressure distribution Dissert Abstr

N82-12041*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

AEROELASTICITY MATTERS: SOME REFLECTIONS ON TWO DECADES OF TESTING IN THE NASA LANGLEY TRANSONIC DYNAMICS TUNNEL

Wilmer H Reed, III Sep 1981 19 p refs Presented at the Intern Symp on Aeroelasticity, Nuremberg, West Germany, 5-7 Oct 1980 - 1 Oct 1981

(NASA-TM-83210) Avail NTIS HC A02/MF A01 CSCL 01A

Testing of wind-tunnel aeroelastic models is a well established, widely used means of studying flutter trends, validating theory and investigating flutter margins of safety of new vehicle designs The Langley Transonic Dynamics Tunnel was designed specifically for work on dynamics and aeroelastic problems of aircraft and space vehicles A cross section of aeroelastic research and testing in the facility since it became operational more than two decades ago is presented Examples selected from a large store of experience illustrate the nature and purpose of some major areas of work performed in the tunnel These areas include. specialized experimental techniques, development testing of new aircraft and launch vehicle designs, evaluation of proposed 'fixes' to solve aeroelastic problems uncovered during development testing, study of unexpected aeroelastic phenomena (i e , 'surprises'), control of aeroelastic effects by active and passive means and, finally, fundamental research involving measurement of unsteady pressures on oscillating wings and control surface A R H

N82-12042*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

EXPERIMENTAL AND ANALYTICAL STUDIES OF A MODEL HELICOPTER ROTOR IN HOVER

F X Caradonna and C Tung Sep 1981 61 p refs Presented at the 6th European Rotorcraft and Powered Lift Aircraft Forum, Bristol, England, 16-19 Sep 1980 Prepared jointly with Army Aviation Research and Development Command

(NASA-TM-81232, A-8332, USAAVRADCOM-TR-81-A-23) Avail NTIS HC A04/MF A01 CSCL 01A

A benchmark test to aid the development of various rotor performance codes was conducted Simultaneous blade pressure measurements and tip vortex surveys were made for a wide range of tip Mach numbers including the transonic flow regime The measured tip vortex strength and geometry permit effective blade loading predictions when used as input to a prescribed wake lifting surface code It is also shown that with proper inflow and boundary layer modeling, the supercritical flow regime can be accurately predicted J M S

N82-12047# ARO, Inc , Arnold Air Force Station, Tenn

EVALUATION AND WIND TUNNEL TESTS OF THE 4,000 LB (NORMAL-FORCE) PITCH/YAW AND ROLL DYNAMIC STABILITY BALANCE SYSTEMS FOR MEASURING DIRECT, CROSS, AND CROSS-COUPLING DERIVATIVES Final Report, 5 Jun. 1978 - 25 May 1979

T D Buchanan, S M Coulter and E J Marquart Sep 1981 79 p refs

(AD-A105122 AEDC-TR-80-12) Avail NTIS HC A05/MF A01 CSCL 20/4

Early in the 1970's, the personnel at the Arnold Engineering Development Center (AEDC) recognized the need for a set of new dynamic test mechanisms for testing aircraft models at high angles of attack At these angles of attack cross and cross-coupling derivatives may be significant in determining the aircraft's stability Dynamic balances were fabricated to perform pitch, yaw, and roll dynamic stability tests of aircraft or large missile models at AEDC The balances were designed to measure not only the direct derivatives but also cross and cross-coupling derivatives The set of balances comprises a 4,000-lb (normal-force) roll and a 4 000-lb pitch/yaw forced-oscillation balance to measure the direct damping derivatives and a five-component can-type balance to measure the cross and cross-coupling derivatives attributable to pitch or yaw Extensive laboratory investigations of the balances' static and dynamic response characteristics were performed before wind tunnel tests of a 1/9-scale F-16A model in the AEDC Propulsion Wind Tunnel (16T) at Mach numbers from 0 2 to 1 4 GRA

N82-12050

APPLICATION OF SINGULAR PERTUBATION THEORY TO ONBOARD AIRCRAFT TRAJECTORY OPTIMIZATION Ph D Thesis

Abhijit J M Chakravarty 1981 139 p

Avail Univ Microfilms Order No 8121183

The problem of minimizing direct operating cost in dollars (combined cost per hour and cost of fuel per hour) for a typical commercial jet transport model is formulated via the Pontryagin minimum principle Singular perturbation theory is applied to reduce the computational burden of solving the resulting optimal control problem The work of p vious investigators is extended to include the aircraft weight v riation in the state equations and the resulting seven-state m del is analyzed for time scale separation It is shown that a .ealistic time scale separation involves only two scales The resulting model is then used to develop the inner and outer solutions as dictated by singular perturbation theory Both the free terminal time problem and the time controlled 4-D problem are considered A comprehensive model for the aerodynamic and fuel flow terms appearing in the equations is developed for use in optimal trajectory computation Numerical results are presented that illustrate the nature of the optimal trajectory and the control variables Dissert Abstr

N82-12051*# Virginia Univ , Charlottesville School of Engineering and Applied Science

TRANSPORTATION SYSTEMS EVALUATION METHODOLOGY DEVELOPMENT AND APPLICATIONS, PHASE 3 Final Report

A Robert Kuhlthau I D Jacobson, and L C Richards Jun 1981 82 p

(Contract NAS1-14908)
(NASA-CR-164999, UVA/528175/MAE-CE81/101) Avail NTIS HC A05/MF A01 CSCL 01B

Transportation systems or proposed changes in current systems are evaluated Four principal evaluation criteria are incorporated in the process, operating performance characteristics as viewed by potential users, decisions based on the perceived impacts of the system, estimating what is required to reduce the system to practice, and predicting the ability of the concept to attract financial support A series of matrix multiplications in which the various matrices represent evaluations in a logical sequence of the various discrete steps in a management decision process is used One or more alternatives are compared with the current situation, and the result provides a numerical rating which determines the desirability of each alternative relative to the norm and to each other The steps in the decision process are isolated so that contributions of each to the final result are readily analyzed The ability to protect against bias on the part of the evaluators, and the fact that system parameters which are basically qualitative in nature can be easily included are advantageous S L

N82-12052*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
INVESTIGATION OF SEVERE LIGHTNING STRIKE INCIDENTS TO TWO USAF F-106A AIRCRAFT
J Anderson Plumer Hampton, Va NASA Langley Research Center Sep 1981 19 p
(Contract NAS1-15884)
(NASA-CR-165794, LT-80-56) Avail NTIS HC A02/MF A01 CSCL 01C

The results of the inspection and analysis of two F-106A aircraft that were struck by separate lightning strikes within a few minutes of each other are presented Each aircraft sustained severe lightning strikes to the pitot booms, resulting in extensive damage to the pitot heater power harness, number 8 ground wire, and lightning suppressors, but there was no damage to either aircraft s electrical or avionic systems A simulated lightning current of 226 kA and 3 8 million A(2)*S was required to reproduce the damage to the ground wires in the radomes Photographs and detailed assessments of the damage are included R J F

N82-12053# Federal Aviation Administration, Washington, D C Office of Aviation Medicine
AN ANALYSIS OF CIVIL AVIATION PROPELLER-TO-PERSON ACCIDENTS, 1965-1979
William E Collins, Angelo R Mastrullo, William R Kirkham, Deborah K Taylor and Paula M Grape May 1981 13 p refs
(AD-A105365, FAA-AM-81-15) Avail NTIS HC A02/MF A01 CSCL 01/2

The interest of manufacturing, governmental, and safety personnel using paint schemes on propeller and rotor blades is based on improving the visual conspicuity of those blades when they are rotating While propeller and rotor paint schemes may serve to reduce the number of fatalities and injuries due to contact with a rotating blade there is little information available regarding analyses of the circumstances surrounding such accidents Brief reports provided by the National Transportation Safety Board of all 'propeller-to-person' accidents from 1965 through 1979 were examined and analyzed in terms of airport lighting conditions, actions of pilots, actions of passengers and ground crew, phase of flight operation weather conditions and others Analyses based on a total of 319 accidents showed a marked drop in the frequency of 'propeller-to-person accidents from 1975 through 1978 Several types of educational efforts directed toward pilots and ground crew, both prior to and during that 4-year period were examined as possible factors contributing to the accident rate decline Accident patterns provide a basis for assessing the probable efficacy of various recommendations (including propeller conspicuity) for further reducing 'propeller-to-person' accidents Author (GRA)

N82-12054# Federal Aviation Administration, Washington D C Office of Aviation Safety
COMPUTER AIR CARRIER SYMPOSIUM
16 Jan 1981 248 p refs Symp held at Washington, D C, 15-16 Jan 1981
(AD-A104894, FAA-ASF-300-81-6) Avail NTIS HC A11/MF A01 CSCL 01/2

Partial Contents Working Session I -- Simulation, Fitness, and Safety Analysis, Working Session II -- Airports and Airways, and Working Session III -- Human Factors GRA

N82-12055# Federal Aviation Administration, Washington, D C Office of Aviation Safety
SUMMARY OF FEDERAL AVIATION ADMINISTRATION RESPONSES TO NATIONAL TRANSPORTATION SAFETY BOARD SAFETY RECOMMENDATIONS Quarterly Report, Jan. - Mar 1981
R E Livingston and C A Carpenter Apr 1981 243 p refs
(AD-A104922 FAA-ASF-81-3) Avail NTIS HC A11/MF A01 CSCL 01/2

This report contains NTSB recommendations and all FAA responses to Board recommendations that were delivered to the Board during the applicable quarter In addition, the report includes NTSB requests and FAA responses concerning reconsiderations, status reports, and followup actions The Table of Contents for this report reflects only those NTSB recommendations which are still open pending FAA action (i e , those that have not been designated as 'Closed by the NTSB as a result of acceptable action) Accordingly, the Table of Contents may reflect a number of multiple recommendations (example A-79-21 through 24), but background material is included only for those recommendations which remain in an 'Open status Background information for those recommendations which have been closed is available in FAA Headquarters files Author (GRA)

N82-12056# Federal Aviation Administration Atlantic City, N J Technical Center
INDEX OF NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER TECHNICAL REPORTS 1972 - 1977 Final Report, 1972 - 1977
Ruth J Farrell comp and Nancy G Boylan, comp May 1981 201 p
(FAA Proj 999-113-000)
(AD-A104759 FAA-CT-81-54) Avail NTIS HC A10/MF A01 CSCL 01/3

This report is an index of all technical reports which were assigned NA numbers and published by NAFEC during the period 1972 through 1977 Entries are arranged by NA number and include titles, authors and full abstracts Separate sections contain indexes by subject, author, and RD number Author (GRA)

N82-12057# Textron Bell Helicopter, Fort Worth, Tex
INVESTIGATION OF THE STRUCTURAL DEGRADATION AND PERSONNEL HAZARDS RESULTING FROM HELICOPTER COMPOSITE STRUCTURES EXPOSED TO FIRES AND/OR EXPLOSIONS Final Report, Mar. 1979 - Dec. 1980
Raymond J Schiltz, Jr Aug 1981 111 p refs
(Contract DAAK51-79-C-0009, DA Proj 1L1-62209-AH-76)
(AD-A104757, USAAVRADCOM-TR-81-D-16) Avail NTIS HC A06/MF A01 CSCL 13/12

A program was undertaken to investigate the structural degradation and personnel hazards resulting from exposure of helicopter composite structures to fire and/or explosion The program consisted of a technical survey, a test program, and an analysis phase A major part of the technical survey was a literature survey In addition, organizations working in the fields of interest were contacted for information and some were visited for further, detailed discussions The computer programs currently available for modeling enclosure fires were screened, and one was chosen for further study The test program consisted of a series of tests on two representative helicopter structures a sheet-stiffened, built-up door of Kevlar 49 fabric impregnated with an epoxy resin, and a honeycomb sandwich fuselage shell structure of graphite/epoxy fabric skins on a Nomex honeycomb core The tests conducted on materials from these structures were smoke generation tests, and structural degradation tests Ballistic tests on the complete test article were conducted to determine whether the structures would ignite under HEI impact conditions Based on the survey and testing, design criteria for structural composite components were investigated and, when appropriate, formulated Author (GRA)

N82-12059# Federal Aviation Administration, Atlantic City, N J
FLIGHT EVALUATION OF LORAN-C AS A HELICOPTER NAVIGATION AID IN THE BALTIMORE CANYON OIL EXPLORATION AREA Final Report, Mar. - May 1979
William A Lynn May 1981 43 p

(FAA Proj 045-390-130)
(AD-A105260, FAA-CT-80-53, FAA-RD-81-27) Avail NTIS HC A03/MF A01 CSCL 17/7

A series of flight tests were conducted to investigate the use of long range navigation (LORAN)-C as a helicopter navigation system in the offshore New Jersey Baltimore Canyon oil exploration area Tests were flown aboard the Federal Aviation Administration (FAA) Technical Center's CH-53A using a Teledyne Systems TDL-711 LORAN Micro-Navigator The purpose of the tests was to determine the accuracy and operational usability of LORAN-C for offshore en route navigation and nonprecision approaches The total system accuracy met or exceeded the requirements of Advisory Circular (AC) 90-45A 'Accuracy Requirements of Area Navigation Systems' for terminal and en route phases of flight, provided the proper LORAN triads were selected The LORAN-C System did not meet AC 90-45A nonprecision approach accuracy criteria Author (GRA)

N82-12060# Federal Aviation Administration, Atlantic City, N J Technical Center

THE USE OF GROUNDSPEED, IN A WIND SHEAR AND THE FLIGHT EVALUATION OF A RADAR-ALTIMETER-BASED SYSTEM FOR THE MEASUREMENT OF GROUND-SPEED Final Report, Jan. 1978 - Oct. 1980

David Lawrence Jul 1981 44 p refs
(AD-A104758, FAA-CT-81-34, ACT-100F) Avail NTIS HC A03/MF A01 CSCL 04/2

The use of groundspeed in combination with airspeed has been considered and shown to be an effective aid in the execution of an approach and landing in a heavy jet transport airplane A flight dynamics analysis shows that the response of such aircraft to sudden changes in headwind is quite sluggish, requiring more than 100 seconds for equilibrium conditions to be regained in the worst case A feasibility demonstration model of a radar-altimeter-based system for the measurement of groundspeed has been subjected to a limited in-flight evaluation It is a self-contained unit requiring no ground-based equipment and no on-board equipment other than the small flush transmit and receive antennas and the associated cable runs While the current unit does not meet the desired accuracy standard (delta = + or 3 knots, or less), it approaches it at times, and greater accuracy can be achieved with further development Responsiveness to rapidly changing groundspeed matched that of the reference inertial navigation system, and satisfactory groundspeed tracking was maintained during turning, climbing, and descending flight Author (GRA)

N82-12061# Ohio Univ , Athens Dept of Electrical Engineering

MLS PERFORMANCE ASSESSMENT, TASK 4. VOLUME 1: EVALUATION PROCEDURES AND EQUIPMENT DESIGN Final Report

Robert W Lilley, Richard H McFarland, and Walter D Phipps Dec 1980 83 p refs
(Contract DOT-FA79NA-6030)
(AD-A105393, EER-47-2-Vol-1, FAA-CT-81-50-Vol-1) Avail NTIS HC A05/MF A01 CSCL 17/7

Preliminary flight-check procedures and system tolerances for the Microwave Landing System (MLS) are presented A data-collection and recording package for use in light-aircraft measurement of MLS parameters in support of the System Test and Evaluation Program (STEP) is included containing a ground reference system, digital telemetry link airborne MLS sensor unit and system computation/display element Author (GRA)

N82-12062# Teledyne Systems Co , Northridge, Calif

DESIGN STUDY REPORT FOR GENERAL AVIATION LORAN-C RECEIVER Final Report

H L Walker and R Ellerbe May 1981 257 p
(Contract DT-FA01-80-C-10108)
(AD-A104921, FAA/RD-81/36) Avail NTIS HC A12/MF A01 CSCL 17/7

This document summarizes the results of studies and trade-off analysis conducted for a low cost Loran-C Receiver The Loran-C Receiver is intended to meet the Minimum Operational Performance Standards for area Navigation (RNAV) equipment for General Aviation Aircraft operating in the National Aerospace System The studies and analysis examined the required receiver performance, design approaches and design criteria, and cost to the user of the receiver The study concludes that a low cost receiver meeting the General Aviation RNAV requirements is practical A design approach for the receiver is described Author (GRA)

N82-12063# Technische Hogeschool, Delft (Netherlands)

ORIENTING DESCRIPTION OF AIR TRAFFIC CONTROL IN THE NETHERLANDS [ORIENTERENDE BESCHRIJVING VAN DE LUCHTVERKEERSLEIDING IN NEDERLAND]

W H vanTuijl Aug 1979 84 p refs In DUTCH
(VTH-LR-285) Avail NTIS HC A05/MF A01

A general impression is given of air traffic control (ATC) in the Netherlands and of the signal automatic radar data processing (SARP) air traffic control system for Schiphol airport emphasizing safety and efficiency Flight conditions, air structure, and navigation and landing aids of the ATL system are described In the SARP system, data relative to position and flight plans are, on a real time basis, processed by a set of computers and distribued Task sharing in SARP, its technical layout, its operational layout, operational functions and flight data are reviewed Author (ESA)

N82-12064# National Aerospace Lab , Amsterdam (Netherlands) Flight Div

THE EFFECT OF VISUAL INFORMATION ON MANUAL APPROACH AND LANDING

P H Wewerinke 28 Apr 1980 20 p refs Presented at 16th Ann Conf on Manual Control, Cambridge, Mass , 5-7 May 1980 Abbreviated version of NLR-TR-80055-U
(NLR-MP-80019-U, NLR-TR-80055-U) Avail NTIS HC A02/MF A01

The effect on approach performance of visual scene information, in combination with basic display information, is discussed for the manual approach and landing task Good, poor, and night visibility conditions are considered, combined with basic head-up display configurations representing a variety of visual cues (runway contours, etc) A pre-experimental model analysis was performed in terms of an optimal control model The resulting aircraft approach performance predictions were compared with the results of a moving base simulator program The results illustrate that the model provides a meaningful description of the visual (scene) perception process involved in the complex (multivariable, time varying) manual approach task with a useful predictive capability The theoretical framework is shown to allow a straight forward investigation of the complex interaction of a variety of task variables Author (ESA)

N82-12065*# Foster-Miller Associates, Inc , Waltham, Mass

EXPERIMENTAL AND ANALYTICAL STUDIES OF ADVANCED AIR CUSHION LANDING SYSTEMS Final Report

E G S Lee, A B Boghani, K M Captain, H J Rutishauser, H L Farley, R B Fish, and R L Jeffcoat' Washington NASA Nov 1981 188 p refs
(Contract NAS1-15051)
(NASA-CR-3476) Avail NTIS HC A09/MF A01 CSCL 01C

Several concepts are developed for air cushion landing systems (ACLS) which have the potential for improving performance characteristics (roll stiffness, heave damping, and trunk flutter), and reducing fabrication cost and complexity After an initial screening, the following five concepts were evaluated in detail damped trunk, filled trunk, compartmented trunk, segmented trunk, and roll feedback control The evaluation was based on tests performed on scale models An ACLS dynamic simulation developed earlier is updated so that it can be used to predict the performance of full-scale ACLS incorporating these refinements The simulation was validated through scale-model tests A full-scale ACLS based on the segmented trunk concept was fabricated and installed on the NASA ACLS test vehicle, where it is used to support advanced system development A geometrically-scaled model (one third full scale) of the NASA test vehicle was fabricated and tested This model, evaluated by means of a series of static and dynamic tests, is used to investigate scaling relationships between reduced and full-scale models The analytical model developed earlier is applied to simulate both the one third scale and the full scale response S L

N82-12066# Aeronautical Research Labs , Melbourne (Australia)

FLIGHT TRAIL OF THE AIRCRAFT FATIGUE DATA ANALYSIS SYSTEM (AFDAS) Mk 2 PROTOTYPE

P J Howard Dec 1980 37 p refs
(AD-A105270, ARL/STRUC-NOTE-466, AR-002-249) Avail NTIS HC A03/MF A01 CSCL 01/3

A prototype version of the Aircraft Fatigue Data Analysis System (AFDAS) has been evaluated in flight trials by a

comparison with continuously recorded data Over a limited period of test the range-mean-pairs count of strain cycles was the same for both sets of data, and the gains calculated for the AFDAS are identical to those deduced from the continuous record Author (GRA)

N82-12067# General Electric Co , Binghamton, N Y Aircraft Equipment Div
ELECTRONIC MASTER MONITOR AND ADVISORY DISPLAY SYSTEM (EMMADS) Final Report, Jun. 1977 - Jun. 1981
Jun 1981 38 p refs
(Contract DAAK80-79-C-0270, DA Proj 1L2-62202-AH-85) (AD-A105082, ACS-12386, USAAVRADCOM-TR-79-F-270) Avail NTIS HC A03/MF A01 CSCL 01/3

The design and fabrication of a programmable feasibility model of an electronic master monitor and advisory display system for helicoptrs is described Functional requirements and system interfaces for signal analysis were determined for the helicopters studied Human factors studies developed formats for reducing crew workloads and maximizing crew performance Methods of data transfer from sensors to the monitor system were analyzed and appropriate interfaces and data transmission media were recommended The programmable feasibility model is discussed R J F

N82-12069# Aeronautical Research Labs , Melbourne (Australia)
A VAPOUR CYCLE CABIN COOLING SYSTEM FOR THE SEA KING MK.50 HELICOPTER
Brian Rebbechi Feb 1980 59 p refs
(AD-A105211, ARL/MECH-ENG-155, AR-001-793) Avail NTIS HC A04/MF A01 CSCL 13/1

An experimental determination has been made of the design requirements for a cabin cooling system in the Sea King Mk 50 helicopter The purpose of this system is to bring the cabin environment in the helicopter to an acceptable level for effective crew performance Cooling was provided by an experimental vapour cycle cooling system Results of the trials have been used to formulate a heat transfer model of the cabin to enable prediction of required cooling capacity for extreme climatic conditions A comparison, based on the trials results, is made between the performance attainable by a vapour cycle cooling system, and an air cycle system using the available engine bleed Author (GRA)

N82-12070# Hochschule der Bundeswehr, Munich (West Germany) Flugmechanik und Flugfuehrung
EFFECTS OF AERODYNAMIC COUPLING ON THE DYNAMICS OF ROLL AIRCRAFT
Gottfried Sachs and Werner Fohrer Jan 1981 48 p refs In GERMAN, ENGLISH summary
Avail NTIS HC A03/MF A01

The effects of coupling of longitudinal and lateral aerodynamic characteristics on the dynamics of aircraft roll were studied, using simplified relations and complete six-degree of freedom calculations The aerodynamic coupling is caused by unsymmetric flow conditions resulting from sideslipping, where rolling moments due to angle of attack and pitching moments due to angle of sideslip, are of particular significance for the problem It is shown that the attainable rate of roll is significantly influenced and that marked effects on stability are possible Furthermore, it is shown that aerodynamic coupling can cause autorotation, i e , a rolling motion without aileron forcing moments Author (ESA)

N82-12072# Engins Matra, Velizy (France) Lab Central
ADVANTAGES AND LIMITATIONS OF VARIOUS MATERIALS USED IN THE CONSTRUCTION OF MODULES [ATOUT ET LIMITES D'EMPLOIS DES DIVERS MATERIAUX UTILISES DANS LA CONSTRUCTION DES CELLULES]
G Hilaire 30 Jul 1981 39 p In FRENCH Presented 9th Colloq Aciers et Alliages Speciaux dans les Ind Aerospatiales, Le Bourget, France, 11 Jun, 1981
(SNIAS-812-551-103, C-42796) Avail NTIS HC A03/MF A01

Steels, light alloys, titanium alloys, and composites are compared for economy, mechanical characteristics, energy content, fatigue effects and toughness The use of these materials in civil and military aircraft, helicopters, and engines is surveyed Increasing use of composites is forecast for the next decade, with a corresponding drop in the use of light alloys Steels and titanium alloys should not be affected Author (ESA)

N82-12074# Air Force Flight Test Center, Edwards AFB, Calif Flight Dynamics Div
AFFTC STANDARD AIRSPEED CALIBRATION PROCEDURES Final Report
Albert G DeAnda Jun 1981 162 p refs
(AD-A104830 AFFTC-TIH-81-5) Avail NTIS HC A08/MF A01 CSCL 01/4

This handbook has been compiled as a reference for use by AFFTC flight test engineers in the standard flight test methods, techniques and procedures for airspeed calibrations Suggested airspeed calibration data reduction methods are presented Some of the information included in this reference applies to the local AFFTC facilities, however, the data reduction outlines are for general application Author (GRA)

N82-12075*# General Electric Co , Lynn, Mass Aircraft Engine Group
EFFECT OF A PART SPAN VARIABLE INLET GUIDE VANE ON TF34 FAN PERFORMANCE Final Report
Jose Alvarez and Paul W Schneider Sep 1981 133 p refs (Contract NAS3-21624)
(NASA-CR-165458, R81AEG030) Avail NTIS HC A07/MF A01 CSCL 21E

Experimental aerodynamic and performance data were obtained from a TF34 engine Part span variable inlet guide vanes mounted in front of the fan on the TF34 engine were tested to demonstrate the feasibility of modulating air flow and thrust for vertical takeoff aircraft systems The fan was mapped to stall for a range of speeds and variable inlet guide were settings Modulated fan tip performance and unmodulated hub performance were evaluated with a without an extended fan bypass splitter The effect of a crosswind distortion screen on performance was also evaluated R J F

N82-12076# Aeronautical Research Labs , Melbourne (Australia) Mechanical Engineering Dept
VIBRATION TEST PROCEDURES FOR ACCESSORY ANGLE DRIVE GEARBOXES ON ATAR 09C ENGINES
P D McFadden and D H Edwards Mar 1981 57 p refs (AD-A105269, ARL/MECH-ENG-TM-408, AR-002-264) Avail NTIS HC A04/MF A01 CSCL 21/5

The Accessory Angle Drive gearbox powers the fuel and hydraulic pumps on the Atar engine in the Mirage aircraft To insure against in-flight failure, each gearbox is vibration tested under load after overhaul by the local contractor A new vibration testing technique, offering greatly improved accuracy and reliability, has been developed The technique uses a real-time, fast-fourier spectrum analyzer, with direct digital read-out in engineering units, and a tracking adapter with built-in antialiasing filter This report defines correct procedures for the connection and operation of the instruments, and the interpretation of the results Author (GRA)

N82-12077# Lucas Group Services Ltd , Solihull (England)
THE USE OF METAL FINISHING IN AIRCRAFT FUEL SYSTEMS
S L Forgham and H L Tulloch 1981 28 p refs
Avail NTIS HC A03/MF A01

Topics discussed are (1) corrosion resistant finishes, (2) finishes to aid manufacture, (3) repair and overhaul, and (4) bearing finishes In the case of (1) hydrogen embrittlement is identified as a major problem and processes generating hydrogen at the surface should be closely controlled Results on drawing size of cadmium plating of rotor blades are presented Various techniques of electrodepositing are compared Pump rig tests on fuels containing chlorides, showing the effect on torque of additives after a 5 hr run and an additional 16 hr standing, are reported Author (ESA)

N82-12078# European Space Agency, Paris (France)
THREE DIMENSIONAL FLOW INVESTIGATION WITH A METHOD OF CHARACTERISTICS IN THE INLET REGION AND THE BLADE-TO-BLADE CHANNELS OF SUPERSONIC AXIAL COMPRESSORS Ph D Thesis - Paris Univ 6
Jean Martinon Sep 1981 341 p refs Transl into ENGLISH of 'Etude, au moyen d'une methode de bicaracteristiques, de l ecoulement tridimensionnel dans la region d'entree et les canaux interaubes d'une roue de compresseurs axiaux supersoniques', ONERA, Paris Report ONERA-P-1979-1, 1979 Original report in FRENCH previously announced as N80-23325
(ESA-TT-637, ONERA-P-1979-1) Avail NTIS

HC A15/MF A01

A three dimensional method of characteristics is developed for the calculation of the supersonic flow in the inlet region and the blade-to-blade channels of blade cascades and high transonic axial flow compressors with subsonic or supersonic axial velocity The numerical scheme is accurate, and required computer times are short Results of calculations on several linear or annular cascades and rotating blade rows are presented and compared with test results Author (ESA)

N82-12079*# Draper (Charles Stark) Lab., Inc., Cambridge, Mass

RELIABILITY ANALYSIS OF THE F-8 DIGITAL FLY-BY-WIRE SYSTEM

L D Brock and H A Goodman Oct 1981 152 p refs (Contract NAS4-2571)

(NASA-CR-163110, R-1324) Avail NTIS HC A08/MF A01 CSCL 01C

The F-8 Digital Fly-by-Wire (DFBW) flight test program intended to provide the technology for advanced control systems, giving aircraft enhanced performance and operational capability is addressed A detailed analysis of the experimental system was performed to estimated the probabilities of two significant safety critical events (1) loss of primary flight control function, causing reversion to the analog bypass system, and (2) loss of the aircraft due to failure of the electronic flight control system The analysis covers appraisal of risks due to random equipment failure, generic faults in esign of the system or its software, and induced failure due to external events A unique diagrammatic technique was developed which details the combinatorial reliability equations for the entire system, promotes understanding of system failure characteristics, and identifies the most likely failure modes The technique provides a systematic method of applying basic probability equations and is augmented by a computer program written in a modular fashion that duplicates the structure of these equations S L

N82-12080*# Virginia Polytechnic Inst and State Univ., Blacksburg Dept of Aerospace and Ocean Engineering

COMPUTATIONAL METHODS OF ROBUST CONTROLLER DESIGN FOR AERODYNAMIC FLUTTER SUPPRESSION Final Report, 14 Nov. 1980 - 15 Nov. 1981

Leonard R Anderson 15 Nov 1981 86 p refs Presented at the 3rd Intern Conf on Math., Calif., 29-31 Jul 1981 Submitted for publication

(Grant NAG1-80)

(NASA-CR-164983, VPI-Aero-125) Avail NTIS HC A05/MF A01 CSCL 01C

The development of Riccati iteration, a tool for the design and analysis of linear control systems is examined First, Riccati iteration is applied to the problem of pole placement and order reduction in two-time scale control systems Order reduction, yielding a good approximation to the original system, is demonstrated using a 16th order linear model of a turbofan engine Next, a numerical method for solving the Riccati equation is presented and demonstrated for a set of eighth order random examples A literature review of robust controller design methods follows which includes a number of methods for reducing the trajectory and performance index sensitivity in linear regulators Lastly, robust controller design for large parameter variations is discussed R J F

N82-12081# Tel-Aviv Univ (Israel) Dept of Electronic Systems

FIXED GAIN CONTROLLER DESIGN FOR AIRCRAFT Final Scientific Report, 1 Jun. 1980 - 31 May 1981

Yoram Baram and Doran Eidelman 30 Jun 1981 31 p refs (Grant AF-AFOSR-0178-80, AF Proj 2301)

(AD-A104877, ESTTR-81-06, SCIENTIFIC-2, EOARD-TR-81-10) Avail NTIS HC A03/MF A01 CSCL 01/3

A Method for designing fixed gain controllers and filters for systems with large parameter variation is presented The approach, based of minimax information criteria, is used to design a non-adaptive back-up control system for a given aircraft and is shown to provide good performance qualities Author (GRA)

N82-12082*# Computer Sciences Corp., Mountain View, Calif

SIMULATOR CERTIFICATION METHODS AND THE VERTICAL MOTION SIMULATOR Final Report

Thomas W Showalter 23 Sep 1981 67 p refs (Contract NAS2-9741)

(NASA-CR-166252) Avail NTIS HC A04/MF A01 CSCL 14B

The vertical motion simulator (VMS) is designed to simulate a variety of experimental helicopter and STOL/VTOL aircraft as well as other kinds of aircraft with special pitch and Z axis characteristics The VMS includes a large motion base with extensive vertical and lateral travel capabilities, a computer generated image visual system, and a high speed CDC 7600 computer system, which performs aero model calculations Guidelines on how to measure and evaluate VMS performance were developed A survey of simulation users was conducted to ascertain they evaluated and certified simulators for use The results are presented S L

N82-12083# National Aerospace Lab., Tokyo (Japan) Aerodynamics Div

CONSTRUCTION AND PERFORMANCE OF NAL TWO-DIMENSIONAL TRANSONIC WIND TUNNEL

1980 104 p refs In JAPANESE, ENGLISH summary

(NAL-TR-647, ISSN-0389-4010) Avail NTIS HC A06/MF A01

The construction and the results of initial calibration are described This tunnel was built to meet the requirements of high Reynolds number testing of wing sections at transonic regime It is a blowdown tunnel with a test section of 0.3m x 1.0m The required capability of this wind tunnel is for Mach numbers ranging from 0.2 to 1.2 and for a Reynolds number up to 40 million at Mach number 0.8 with sufficient running time An outline of the design objectives is given The completed facilities, i.e., the wind tunnel, the instrumentation and operation system, the silencer and auxiliary equipment of the air compressor and the air reservoir, are described in detail The performance of the tunnel when it is empty is described, and the results of a few experiments with an airfoil model of the NACA 64A410 are presented High Reynolds number testing can be achieved in this wind tunnel without any trouble B W

N82-12085*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

A LOOK INSIDE THE LANGLEY 16-FOOT TRANSONIC TUNNEL. USER'S GUIDE

Kathryn H Peddrew, comp Aug 1981 197 p refs

(NASA-TM-83186) Avail NTIS HC A09/MF A01 CSCL 14B

The 16-foot transonic tunnel is a single-return atmospheric wind tunnel having a slotted test section The primary emphasis for research in this facility is the integration of the propulsion system into advanced aircraft concepts The large test section size, 15.5 feet in diameter lends itself to conducting research in this area, where large models are required in order to provide adequate definition of the model geometry associated with the integration of the propulsion system The nominal test Mach number range for this facility varies from 0.20 to 1.3 Topics covered include (1) facility description, (2) model installation equipment for aerodynamics, (3) model support system for propulsion simulation testing, (4) propulsion simulation systems, (5) calibrating propulsion simulation systems, (6) instrumentation, (7) data acquisition, (8) model design criteria, and (9) wind tunnel test planning A R H

N82-12142*# Boeing Commercial Airplane Co., Seattle, Wash

IN-SERVICE INSPECTION METHODS FOR GRAPHITE-EPOXY STRUCTURES ON COMMERCIAL TRANSPORT AIRCRAFT Final Report

M L Phelps Nov 1981 105 p refs (Contract NAS1-15304)

(NASA-CR-165746) Avail NTIS HC A06/MF A01 CSCL 11D

In-service inspection methods for graphite-epoxy composite structures on commercial transport aircraft are determined Graphite/epoxy structures, service incurred defects, current inspection practices and concerns of the airline and manufacturers, and other related information were determind by survey Based on this information, applicable inspection nondestructive inspection methods are evaluated and inspection techniques determined Technology is developed primarily in eddy current inspection S L

N82-12143# McDonnell Aircraft Co., St Louis, Mo

EFFECT OF FIGHTER ATTACK SPECTRUM ON COMPOSITE FATIGUE LIFE Final Report, Sep. 1978 - Oct. 1980

R Badaliance and H. D Dill Mar 1981 126 p refs

(Contract F33615-78-C-3218, AF Proj 2401)
(AD-A105034, AFWAL-TR-81-3001) Avail NTIS HC A07/MF A01 CSCL 11/4

The objective was to evaluate the effect of fighter wing load spectrum variations on the life behavior of composite structures Six types of spectra were generated (a) clipping to 90% test limit stress, (b) addition of stress overloads, (c) addition of low loads, (d) truncation to 70% test limit stress, (e) clipping of tension loads, (f) increased severity and number of air-to-air loads A single hole compression test specimen was designed to simulate fatigue critical areas of fighter wing skins GRA

N82-12168*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

FIRE EXTINGUISHANT MATERIALS Patent Application

Robert L Altman, Ludwig A Mayer (San Jose State Univ.), and Alan C Ling, inventors (to NASA) (San Jose State Univ.) Filed 3 Nov. 1981 11 p
(NASA-Case-ARC-11252-1, US-Patent-Appl-SN-317977) Avail NTIS HC A02/MF A01 CSCL 21B

Fire extinguishant materials were developed for extinguishing fires on hot metal surfaces caused by liquid fuels such as jet engine fuels The composition of the materials is a mixture of a finely divided aluminum compound and alkali metal, stannous or plumbous halide The aluminum compound may be aluminum hydroxide, alumina or boehmite, but preferably it is an alkali metal dawsonite The metal halide may be an alkali metal, e g potassium iodide, bromide, or chloride, or stannous or plumbous iodide, bormide, or chloride Potassium iodide is preferred The presence of the halide improves the performance of the aluminum compound in extinguishing fires on hot metal surfaces NASA

N82-12178# Atlantic Research Corp., Alexandria, Va Combustion and Physical Science Dept

CHEMISTRY OF COMBUSTION OF FUEL-WATER MIXTURES Final Technical Report, 1 Jun. 1980 - 31 May 1981

Edward G Skolnik, Edward T McHale, and Harley L Heaton Sep 1981 51 p refs
(Contract N00014-80-C-0534)
(AD-A105401) Avail NTIS HC A04/MF A01 CSCL 21/2

The continuation of an experimental flame study concerning the nonphysical processes that lead to soot suppression when water is added to fuel, begun in a previous program is reported The study included a mapping of temperature, chemical species and soot profiles of laminar diffusion flames with and without water added Fuels studied included ethylene and a benzene/hydrogen mixture Flames with nonreactive gases added (argon, nitrogen), were also studied for comparison purposes The study concludes that the reduction of soot by water in an ethylene diffusion flame can be completely explained by thermal effects The results are not as definitive for benzene The addition of water causes a greater reduction in soot than does a thermally equivalent addition of argon, but no noticeable differences in chemical species profiles are observed There is evidence, however, that water addition causes an increase in concentration of an oxygen-containing tarry substance present in the flame prior to soot formation During the course of the study it was also possible to estimate both soot particle diameters (1-2 x 000001 cm at the beginning of the oxidation zone) and an activation energy for soot oxidation by the OH radical (7-8 kcal/mole) In addition, it was possible to confirm the presence of and quantify the oxygen concentration in the center of diffusion flames, first reported under the previous program Author (GRA)

N82-12216*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

PROGRESS IN PROTECTIVE COATINGS FOR AIRCRAFT GAS TURBINES A REVIEW OF NASA SPONSORED RESEARCH

John P Merutka 1981 29 p refs Presented at the 5th Ann Conf on Composite and Adv Mater., Merritt Island Fla 19-22 Jan 1981, sponsored by the Am Ceramic Soc., Inc
(NASA-TM-82740, E-711) Avail NTIS HC A03/MF A01 CSCL 11F

Problems associated with protective coatings for advanced aircraft gas turbines are reviewed Metallic coatings for preventing titanium fires in compressors are identified Coatings for turbine section are also considered, Ductile aluminide coatings for protecting internal turbine-blade cooling passage surface are also identified Composite modified external overlay MCrAlY coatings deposited by low-pressure plasma spraying are found to be better in surface protection capability than vapor deposited MCrAlY coatings Thermal barrier coating (TBC), studies are presented The design of a turbine airfoil is integrated with a TBC, and computer-aided manufacturing technology is applied S L

N82-12230* International Harvester Co., San Diego, Calif.

FORMULATION AND CHARACTERIZATION OF POLYIMIDE RESILIENT FOAMS OF VARIOUS DENSITIES FOR AIRCRAFT SEATING APPLICATIONS Final Report, 15 Feb. 1980 - 30 Sep. 1981

J Gagliani, R Lee, and U A. K. Sorathia 30 Sep 1981 151 p refs
(Contract NAS9-16009)
(NASA-CR-167421, CSR81-R-4834-20) Avail NTIS HC A08/MF A01 CSCL 11G

Light weight, heat and fire resistant low smoke generating polyimide foams are developed for aircraft seating applications The material is upgraded and classified into groups for fabrication of cushions possessing acceptable comfort properties Refinement and selection of foaming processes using a variety of previously developd foaming techniques and definition of property relationships to arrive at the selection and classfication of polyimide foams into five groups in accordance with predetermined ILD values are emphasized S L

N82-12248# Rensselaer Polytechnic Inst., Troy, N Y Dept of Mechanical Engineering.

DETERMINATION AND ANALYSIS OF JET AND MISSILE FUEL DEPOSITS Final Report

James L Lauer 14 Aug 1981 32 p
(Contract N00164-79-M-2522)
(AD-A105458, NWSC/CR-RDTR-151) Avail NTIS HC A03/MF A01 CSCL 21/4

Jet fuel deposits, some of them supplied on their original support by Dr Hazlett of the Naval Research Laboratory, were examined by attenuated total reflection spectroscopy and by infrared Fourier transform emission spectroscopy for the purpose of finding a procedure suitable for in situ analysis The infrared radiation emitted by samples at 50-65 C was adequate for qualitative analysis, which can readily be made quantitative by further work Definite sharp peaks corresponding to aromatic materials were found Author (GRA)

N82-12255# Brookhaven National Lab., Upton, N Y Catalyst Group

DEVELOPMENT OF CATALYTIC SYSTEMS FOR THE CONVERSION OF SYNGAS TO JET FUEL AND DIESEL FUEL AND HIGHER ALCOHOLS Annual Report

William A Slegeir Oct 1980 18 p
(Contract DE-AC02-76CH-00016)
(DE82-000067, BNL-51423) Avail NTIS HC A02/MF A01

A highly active series of Fischer-Tropsch catalysts are developed on the basis of insights provided by the oxide theory. The method of catalyst formulation is unique in Fischer-Tropsch chemistry, yet is simple and reproducible These catalysts are superior to ordinary catalysts for hydrocarbon synthesis with regard to rate, operating conditions, and, product selectivity and longevity. The products of these catalysts are ideally suited for use as diesel and jet fuels Once formed, the catalysts display remarkable stability toward air Oxide interactions, the role of promoters, and the synergistic behavior of bimetallic catalysts systems are studied Bimetallic systems for hydrocarbon and alcohol synthesis are discussed DOE

N82-12303# Federal Aviation Administration, Atlantic City, N J

MOVING TARGET DETECTOR/AIRPORT SURVEILLANCE RADAR (ASR-7) FIELD EVALUATION Final Report, Feb. 1979 - Jan. 1980

W Goodchild Aug 1981 52 p refs
(AD-A105196, FAA-CT-81-31, FAA-RD-81-57) Avail NTIS HC A04/MF A01 CSCL 17/7

The Moving Target Detector (MTD) II, a sophisticated radar processor, was evaluated to determine its capability to provide improved radar detection in an air traffic control (ATC) environment The MTD II was installed on one channel of an airport surveillance radar (ASR-7) at Burlington, Vermont The major objective of testing was to compare the performance of the MTD II with that of the ASR-7 Moving Target Indicator (MTI) This report concentrates on the comparative probability of detection, false alarm rate, MTI improvement factor, subclutter

visibility, dynamic range, velocity response, and the simultaneous flight test results of the two systems Comparison of the MTD II to the MTD I system is made when necessary to show major improvements or deficiencies in the MTD II design The results of the tests have shown that the MTD II provides surveillance capabilities superior to those of the ASR-7/MTI Author (GRA)

N82-12304# Federal Aviation Administration, Atlantic City, N J
COLUMBUS, OHIO, VOICE RESPONSE SYSTEM DEMONSTRATION AND EVALUATION Final Report, Dec. 1979 - Apr 1980
John C Henline Jun 1981 54 p
(FAA Proj 131-402-854)
(AD-A104750, FAA-CT-80-50, FAA-RD-81-20) Avail NTIS HC A04/MF A01 CSCL 17/2

The Voice Response System (VRS) was subjected to a 4-month demonstration in the Columbus, Ohio, Flight Service Station (FSS) preflight area The purpose of the experiment was to test and evaluate the VRS system, user acceptance, and the effects on the specialists/facility workload, and to determine the general impact of VRS on the Columbus (CMH) FSS preflight area In addition, the test permitted collection of technical performance data which could serve as the framework for an integrated national system for the mass dissemination of weather information It is concluded that the VRS caused a shift in user demand/preference, reduced FSS briefer workload, reduced demand for basic pilots automatic telephone weather answering service (PATWAS), and was determined to be acceptable to the general aviation user Author (GRA)

N82-12392# ARO, Inc , Arnold Air Force Station, Tenn
AN INVESTIGATION OF F-16 NOZZLE-AFTERBODY FORCES AT TRANSONIC MACH NUMBERS WITH EMPHASIS ON MODEL SCALE EFFECTS Final Report, Oct. 1979 - Sep. 1980
Earl A Price, Jr Sep 1981 149 p *refs*
(AD-A104905, AEDC-TR-80-57, AFWAL-TR-81-2110) Avail NTIS HC A07/MF A01 CSCL 20/4

An experimental program was conducted to provide nozzle-afterbody data with a minimum interference support system on a 0 25-scale F-16 model and to determine the interference induced *on then nozzle-afterbody region by sting and strut model support* systems Data obtained on the 0 25-scale model are compared with data from a 0 11-scale model for evaluation of model scale effects The investigation was conducted over the Mach number range from 0 6 to 1 5 Data are presented in terms of coefficients and increments in coefficients of nozzle-afterbody axial and normal forces obtained from integrating pressure data High-pressure air at ambient temperature was utilized for exhaust plume simulation The results indicate close agreement in axial-force coefficient between configurations having full and annular nozzles at design pressure ratio Very little effect of Reynolds number was found on the nozzle-afterbody axial force Wave interference adversely affected axial-force data from the 0 25-scale model at Mach numbers between 1 0 and 1 1, producing lower axial force on the model afterbody Large differences were determined in both the magnitude and the sign of strut interference from the two model installations Author (GRA)

N82-12448# Naval Ocean Systems Center, San Diego, Calif
PORTABLE AIR DRIVEN VARIABLE SPEED FIBER OPTIC CABLE TERMINATION POLISHER Technical Report, Mar. 1979 - Aug. 1980
A Flores 15 Mar 1981 46 p refs
(AD-A104797, NOSC/TR-708) Avail NTIS HC A03/MF A01 CSCL 13/8

Manufacturing processes and techniques were developed to produce in larger volume a portable air driven variable speed fiber optic cable polisher with the necessary characteristics to perform in the operational environments encountered during installation and maintenance of fiber optic cables in military aircraft Author (GRA)

N82-12648# Joint Publications Research Service, Arlington, Va
GERMAN-ARGENTINE EXPERIMENT: VERTICAL-ROTOR WIND ENGINE
Peter Raabe *In its* W Europe Rept Sci and Technol , No 72 (JPRS-78876) 1 Sep 1981 p 18-19 Transl into ENGLISH from Tagesspiegel (Berlin), 4 Jul 1981 p 12

Avail NTIS HC A03/MF A01

Designed by aerodynamists, a wind motor built in Patagonia, is independent of the direction of the wind due to its vertical rotating axis The narrow rotor blades have optimum aerodynamic efficiency Drum-like wind collectors at the top and bottom of the rotating axis serve as starters The plant incorporates simple instead of sophisticated mechanical parts, and its maintenance requirements are extremely low Only the two rotating bearings located at the top and bottom of the axis require lubrication, with the oil being changed only twice a year A R H

N82-13014# Systems Control, Inc , West Palm Beach, Fla Technology Industries Div
ANALYSIS OF INTEGRATED FUEL-EFFICIENT, LOW-NOISE PROCEDURES IN TERMINAL-AREA OPERATIONS
J B McKinley Jan 1981 125 p refs
(Contract DE-AC01-80CS-50141)
(DE81-029833, DOE/CS-50141/T1) Avail NTIS HC A06/MF A01

The specific aviation energy conservation issues, terminal area fuel conservation and airport noise level relationships, are investigated The potential fuel savings and noise level reduction in the Los Angeles International (LAX) terminal area between 1980 and 1990 attributable to compliance with the noise *requirements of FAR Part 36 were quantified These savings* are due to the retiring, retrofitting and re-engining of older narrow-body aircraft (DC-8, B707, etc) and the growth of wide *body aircraft operations (DC-10, B747, B767, etc) Current noise* abatement procedures that could be relaxed without adversely impacting current (1980) noise levels, and at the same time *conserving additional fuel Two FAA computer models were used* The Integrated Noise Model (INM) Version 2 7, was used for noise analysis and INKMOD, a preliminary fuel burn model, for *the fuel analysis The results of this detailed analysis revealed* that due to the changing aircraft mix at LAX to include more wide body aircraft and fewer narrow body aircraft operations, airport noise level will decrease by 8 5 and 9 2 square miles on the 75 Ldn contour for 1985 and 1990, respectively, from the 1980 baseline DOE

N82-13043*# National Aeronautics and Space Administration Langley Research Center Hampton, Va
RESEARCH AND TECHNOLOGY Annual Report
Nov 1981 68 p
(NASA-TM-83221) Avail NTIS HC A04/MF A01 CSCL 05B

Langley Research Center is engaged in the basic an applied research necessary for the advancement of aeronautics and space flight, generating advanced concepts for the accomplishment of related national goals, and provding research advice, technological support, and assistance to other NASA installations, other government agencies, and industry Highlights of major accomplishments and applications are presented S L

N82-13048# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France)
THE IMPACT OF NEW GUIDANCE AND CONTROL SYSTEMS ON MILITARY AIRCRAFT COCKPIT DESIGN
Aug 1981 217 p refs In ENGLISH, partly in FRENCH Symp held in Bad-Cannstatt, West Germany, 5-8 May 1981
(AGARD-CP-312, ISBN-92-835-0297-3) HC A10/MF A01

The requirements and technologies involved in control systems were reviewed Topics incude, displays, controls/displays system integration, automated systems/man interface, and cockpit systems evaluation Emphasis is placed on the design of a cockpit layout with controls and displays that maximize the overall aircraft capability while keeping the pilot's workload within bounds by the use of more automation of system management For individual titles, see N82-13049 through N82-13064

N82-13049# Textron Bell Helicopter, Fort Worth, Tex Human Factors and Cockpit Arrangement Group
HOW THE HELICOPTER COCKPIT DESIGNER USES DIGITAL AVIONICS
John H Emery *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 13 p ref
Avail NTIS HC A10/MF A01

An overview of the approaches to helicopter cockpit design made possible through the application of advanced multiplex technology to cockpit displays and controls is presented This technology enables the pilot to have more information available while, at the same time, reducing his workload, and provides

for substantially improved cockpit management One of the major research programs through which this technology was tailored for military helicopters is ADAS (Army Digital Avionics System) This program is discussed, along with Bell helicopter cockpit designs T M

N82-13050# Smiths Industries Ltd , Bishops Cleeve (England) Aerospace and Defense Systems
ELECTRONIC FLIGHT DECK DISPLAYS FOR MILITARY TRANSPORT AIRCRAFT
R A Chorley *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 12 p refs
Avail NTIS HC A10/MF A01

These display systems offer operational and economic advantages which can be realized in military as well as in civil aircraft In particular, the flexibility of the display formats which can be provided, and the ease with which the information content can be changed, enable all the information required for the control of a transport aircraft to be displayed on the main panel, and go a long way towards making operation by a two-man crew possible In addition, the flexibility of an electronic display system makes it feasible to minimize the effect of failures within the display system to an extent which is impossible in the case of conventional instruments Full realization of this capability, which calls for careful selection of the system architecture to be employed, may lead to a significant in mission success A discussion of CRT displays is presented T M

N82-13051# Aeronautical Systems Div , Wright-Patterson AFB, Ohio Directorate of Avionics Engineering
COLOR CRT DISPLAYS FOR THE COCKPIT
Harry L Waruszewski *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 22 p refs
Avail NTIS HC A10/MF A01

Color displays are currently being proposed for installation or are being installed in civilian and military aircraft cockpits The complexity of designing a good color display is much greater than that of a monochromatic display The human factors data and cockpit requirements needed to develop color cockpit displays so that requirements for a usable display can be generated are discussed The color display technology was evaluated with respect to satisfying the established human factors requirements Test methodologies need to be developed to determine compliance of the color displays to the specification requirement Finally, the need for displays to be integrated into the cockpit using total cockpit human factors criteria to maximize the possible workload reduction and safety of the aircraft is discussed T M

N82-13052# Thomson-CSF, Paris (France)
HEAD UP DISPLAYS
Claude Maureau *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 7 p
Avail NTIS HC A10/MF A01

The displays present information to pilots without depriving them of a simultaneous external view This implies that head-up dispdisplays are collimated displays The problems involved with collimation are discussed and the possibility of head-up providing pilots with directional information is considered T M

N82-13053# Army Avionics Research and Development Activity, Fort Monmouth, N J
INTEGRATION OF CONTROLS AND DISPLAYS IN US ARMY HELICOPTER COCKPITS
J A Dasaro and C T Elliott *In* AGARD The Impacts of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 19 p refs

Avail NTIS HC A10/MF A01

Expanded missions such as anti-armor, night surveillance, and air-to-air, coupled with the survivability requirement of nap-of-the-Earth flight, dictate the approach to cockpit design This approach must apply the latest technological innovations in the areas of controls, displays multiplexing, and microprocessors to unburden the pilot Space, weight, and cost constraints placed on the cockpit system designers must also be satisfied The U S Army completed a full scale engineering development program in the area of cockpit integration, and is currently involved in a more ambitious exploratory development effort An overview of these efforts to integrate the helicopter cockpit, including results of simulation experiments and operational flight tests, is presented T M

N82-13054# Collins Radio Co , Cedar Rapids, Iowa Government Avionics Div
A STANDARD CONTROL DISPLAY UNIT FOR MULTI-AIRCRAFT APPLICATION
Ronald L Swanson and Craig R Scougton *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 10 p

Avail NTIS HC A10/MF A01

The need for standardization of military hardware is well documented both within the US DOD and NATO Standardization issues revolve mainly around interoperability, logistics, and life-cycle cost advantages The issue of standardization and its suitability in the design of aircraft control/display units (CDU) is addressed Potential benefits, requirements, and remaining problems associated with standardization of avionics control displays are discussed Included is a discussion of a CDU that is currently being produced which has many of the features considered essential to the ultimate standard CDU T M

N82-13056# Crouzet Aerospace and Systems, Valence (France)
USING VOICE CONTROL ONBOARD COMBAT AIRCRAFT [UTILISATION DE LA COMMANDE VOCALE A BORD DES AERONEFS DE COMBAT]
J R Coster and J M Melocco *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpits Design Aug 1981 5 p In FRENCH

Avail NTIS HC A10/MF A01

The use of the voice would be a valuable tool in resolving problems associated with pilot workload, in reducing the surface of the flight instrument system and the complexity of the man machine interface in high performance combat aircraft A program established at the Laboratory of Information for Mechanics and Engineering Sciences validates in aircraft environments the methods of speech recognition and synthesis developed in research laboratories It is merely a matter of the universal recognition, at the acoustic level of isolated words pronounced by a single speaker The techniques used are described These include laboratory experiments involving an aeronautical dialog in a noisy environment and experimentation with a simulator of a vocal dialog applied to an aircraft with modern weapons and to the study of human factors Experimentation also takes place in a flight simulator Transl by A R H

N82-13060# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst fuer Flugfuehrung
EXPERIMENTAL INVESTIGATION OF A HELMET MOUNTED SIGHT/DISPLAY FOR HELICOPTER
R Beyer, E Danneberg, E Kohnen, and H Stein *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 11 p

Avail NTIS HC A10/MF A01

A helmet mounted sight/display (HMS/D) combined with an infrared camera and electronic instrument displays was investigated as a guidance aid for the low level flight of helicopters at night The static and dynamic accuracy of the tracking mechanism which aligns the lines of sight of both the pilot and the camera was determined by means of a target and motion simulator System performance was checked with a Bo 105 helicopter in low level flight at night From the results obtained the importance of the HMS/D as an guidance aid becomes evident relative to other night vision/display systems Author

N82-13061# Royal Aircraft Establishment, Farnborough (England) Flight Systems Dept
USE OF A HELMET-MOUNTED MATRIX DISPLAY FOR PRESENTING ENERGY-MANEUVERABILITY INFORMATION DURING SIMULATED CLOSE COMBAT
D N Jarrett *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 10 p refs
Avail NTIS HC A10/MF A01

Since continuous visual contact display (HMMD) with the

enemy is essential in close combat the provision of this information on a helmet-mounted diplay (HMMD) may be particularly useful However, the (in) visibility of the image against a bright sky background, the increased helmet weight and other inconveniencing counter effects when coupled with the high attentional and physical demands of combat, may obviate any advantages of controlling the aircraft using the extra information A series of exercises was set up to assess the HMMD in this application The device was the subject of a flight trial in a light jet aircraft, and two studies were completed in the newly-commissioned RAE air combat simulator These studies enabled pilots to become familiar with the device and the unusual display format, in order to assess their combined usefulness in a combat context A R H

N82-13063# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio
TANKER AVIONICS AND AIRCREW COMPLEMENT EVALUATION
Richard W Moss and Gregory J Barbato (Bunker-Ramo Corp, Dayton, Ohio) *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 18 p refs
Avail NTIS HC A10/MF A01

A four phase effort addressing the control and display design issues associated with operating the SAC'S KC-135 tanker without the navigator crew position is discussed Topics covered include the mission analysis phase during which the tanker's operational responsibilities were defined and documented, the design phase durng which alternative crew station design concepts were developed, the mockup evaluation phase which accomplished initial SAC crewmember assessment of cockpit designs, and the simulation phase which validated the usability of the crew system redesign A recommended crew station configuration is examined and some of the philosophy underlying the selection of cockpit hardware and systems is discussed A R H

N82-13064# McDonnell Aircraft Co, St Louis, Mo
F/A 18 HORNET CREW STATION
Eugene C Adam *In* AGARD The Impact of New Guidance and Control Systems on Mil Aircraft Cockpit Design Aug 1981 6 p
Avail NTIS HC A10/MF A01

The Hornet crew station design requirement was to essentially provide the capability contained in both the F-4 and A-7 weapon systems so as to perform both the fighter attack roles, make it operable by one pilot, and increase mission reliability by a combination of improved hardware reliability and functional redundancy To put this requirement in perspective, the F/A-18 cockpit has 40% less usable area than any of its contemporaries This area constraint necessitated extensive integration of the weapon system controls and displays The resultant crew station features four miltipurpose cathoderay displays driven by two mission computers, an integrated upfront control panel, and numerous automatic functions on the stick and throttle The rationale leading up to the configuration is described and a few examples of the one-man-operability features of the Hornet and how they would used by the pilot are presented A R H

N82-13065# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France)
AERODYNAMICS OF POWER PLANT INSTALLATION
Sep 1981 510 p refs In ENGLISH and FRENCH Proc of conf held in Toulouse, 11-14 May 1981
(AGARD-CP-301, ISBN-92-835-0301-5) Avail NTIS HC A22/MF A01

The aerodynamic problems in power plant installation are surveyed and computational and design methodologies are presented Combat aircraft intakes, afterbodies and nozzles, testing and analysis techniques, and installation aerodynamics of transport aircraft are addressed For individual titles, see N82-13066 through N82-13098

N82-13066# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio
PERFORMANCE OF HIGHLY INTEGRATED INLETS FOR SUPERSONIC AIRCRAFT
Lewis Surber, Jan Syberg, and Joseph Koncsek *In* AGARD Aerodyn of Power Plant Installation Sep 1981 12 p refs Prepared in cooperation with Boeing Military Airplane Co, Seattle
Avail NTIS HC A22/MF A01

Performance data obtained on several subsonic diffusers applicable to advanced supersonic tactical aircraft configurations were used to select a forebody-inlet model for proof-of-concept wind tunnel performance evaluation Three of the diffusers were designed for high aspect ratio inlets having throat aspect ratios greater than seven A fourth design incorporated a low aspect ratio inlet Two of the high aspect ratio diffusers and the low aspect ratio diffuser incorporated duct bends typical of inlets substantially offset from the engine centerline Preliminary tests of the high aspect of ratio diffuser produced high total pressure recovery coupled with relatively low flow distortion Furthermore, the use of longitudinal vanes in one high aspect ratio diffuser provided reductions in engine face flow distortion with very little performance degradation Proof-of-concept tests further investigated the performance of a high aspect ratio, side-mounted external compression supersonic inlet Tests were performed in a 16-foot supersonic propulsion wind tunnel at Mach numbers of 1 6 to 2 2 over a -5 to 12 deg angle of attack range and sideslip angles from -8 to +8 deg The results of these tests support the use of high aspect ratio inlets with sharp duct bends as a viable design option in future supersonic aircraft designs M G

N82-13068# Royal Aircraft Establishment, Bedford (England) Aerodynamics Dept
SOME RAE RESEARCH ON SHIELDED AND UNSHIELDED FUSELAGE MOUNTED AIR INTAKES AT SUBSONIC AND SUPERSONIC SPEEDS
J A Ross, I McGregor, and A J Priest *In* AGARD Aerodyn of Power Plant Installation Sep 1981 16 p refs
Avail NTIS HC A22/MF A01

The incidence performance of fuselage-mounted intakes at subsonic and supersonic speeds is examined The effects of simple changes in intake geometry, such as increasing contraction ratio and altering lower lip shape, are first considered, it is shown that such modifications can be beneficial at subsonic speeds, but drag penalties tend to limit their use at higher Mach numbers Two intake locations that potentially offer a good degree of incidence shielding - underfuselage and understrake - are then examined It is concluded that satisfactory performance can be obtained with an understrake installation, but a detailed study of strake shape, slots, splitter plates and boundary layer diverters must be made if the combinaion is to be successful over the whole of the intended flight envelope However, for the configurations tested, the underfuselage location offers generally better intake performance lower technical risk Finally, some results for a side-mounted staggered lip intake are presented, together with some two dimensional calculations of the mutual interference effects that occur between the upper and lower lips It is suggested that an intake of this type can be competitive with an underfuselage installation M G

N82-13069# National Gas Turbine Establishment, Pyestock (England)
PREDICTION AND MEASUREMENT OF TIME-VARIANT, THREE-DIMENSIONAL FLOWS IN MILITARY AIRCRAFT INTAKES
D E Colbourne and J E Flitcroft *In* AGARD Aerodyn of Power Plant Installation Sep 1981 18 p refs
Avail NTIS HC A22/MF A01

The development of a computational method suitable for predicting the three dimensional flows within the diffuser sections of aircraft intakes is described A fast method for automatic grid generation, application to ducts of any smoothly varying cross-sectional shape, is discussed The development of a finite-volume, time-marching method for solving the flow equations is also described The validity of the chosen techniques is discussed in the light of comparisons with analytical and empirical results Empirical techniques were developed to examine flows in which viscous or time variant effects are dominant A rotating yaw meter rake was developed to undertake detailed flow surveys at the exit of model diffusers, and results may be obtained from tests both in isolation and in the presence of a compressor The development of instrumentation and data processing facilities for measuring instantaneous engine face total pressure distortion in small scale models is also described, together with the validation of this technique by comparison with results from a full-size replica of the intake tested under free-jet conditions M G

N82-13070# British Aerospace Aircraft Group, Bristol (England)
EFFECTS OF INTAKE GEOMETRY ON CIRCULAR PITOT

INTAKE PERFORMANCE AT ZERO AND LOW FORWARD SPEEDS

A C Willmer, T W Brown, and E L Goldsmith (RAE, Bedford, England) *In* AGARD Aerodyn of Power Plant Installation Sep 1981 16 p refs Sponsored in part by Ministry of Defence

Avail NTIS HC A22/MF A01

A series of experiments on circular cross-section pitot intakes at Mach numbers from 0 to 0.21 and angles of incidence and sideslip from 0 to 40 deg are presented. Measurements were made at the engine face of 72 pitot pressures 4 unsteady pitot pressures, swirl angle at six positions, and boundary layer profiles at four positions. Static pressure distribution around the cowl lips and along the diffusers were also measured. Five cowl lips covering a range of contraction ratios and lip shapes were tested with both a straight and an S bend diffuser. The effect of inserting parallel section spacers between the cowl lip and the front of the subsonic diffuser and between the end of the subsonic diffuser and the engine face instrumentation and the effect of a thin lip slot upstream of the intake throat were evaluated. Results indicate that, lip losses may be decreased by increasing contraction ratio, fitting a lip slot or a forward spacer. Steady state flow distortion at the engine face is decreased by increasing lip contraction ratio or by fitting an aft extension. For the S duct tested, distortion levels are set by the diffuser as much as by incidence. Sideslip however lessens the distortions. M G

N82-13071# Institut de Mecanique des Fluides de Lille (France)

TRANSONIC FLOWS IN AN AIR INLET WITH LARGE INCIDENCE AND THE EFFECT OF A BLOWING TRAP [ECOULEMENTS TRANSSONIQUES DANS UNE PRISE D'AIR EN GRANDE INCIDENCE AT EFFET DE TRAPPE DE SOUFFLAGE]

A. Dyment, P. Gryson, and J. P. Flodrops *In* AGARD Aerodyn of Power Plant Installation Sep 1981 13 p ref In FRENCH

Avail NTIS HC A22/MF A01

Flow in a bidimensional air intake with large incidence was studied under conditions in which the upstream flow was subsonic and the internal flow could be regulated. The phenomena following flow separation were examined, especially the homogenization of the internal flow. A device for improving mogenization which involves a natural deflection accomplished by a scoop designed to guide the captivated air was tested. The universal aspect of internal flow was studied using probes in different sections. The unsteady phenomena were analyzed from ultra high speed visualizations and the mean flow was characterized from classic visualization. The insertion of the deflector appreciably improved the performance of the air intake. The coefficient of output (sigma) and the total mean pressure (P sub tm) were considerably improved at the level of the compressor. While the use of the scoop to guide the air towards the slot had only a weak influence on sigma and P sub tm at the compressor level, it brought an appreciable gain in the speed of homogenization of the internal flow. Transl. by A R H

N82-13073# Aeritalia S p A Torino (Italy) Combat Aircraft Group

SUBSONIC MILITARY AIRCRAFT ENGINE INTAKE AN INTEGRATED THEORETICAL EXPERIMENT DESIGN

G. Bertolone and L. Fornasier *In* AGARD Aerodyn of Power Plant Installation Sep 1981 17 p refs

Avail NTIS HC A22/MF A01

Two numerical codes were developed for the simulation of the engine intake-induced flow field in two dimensional transonic and three dimensional subsonic cases. Both codes were obtained by modification of existing codes suitable for the computation of the exterior flow past airfoils (by a finite element method) and about three dimensional arbitrary configurations (by a panel method). Computed results and comparison with experimental data pertinent to the analysis of a single bifurcated intake proved usefulness of the present numerical schemes for engineering applications. Engine face auxiliary doors design and side intakes diverter shape optimization was studied. Following an extensive testing program performed on a static model the engine face auxiliary doors with annular air admission into the primary long type duct appeared to be a good alternative to the classical solution placed at the main inlet entry. Diverter geometry influence both on aerodynamics in terms of drag coefficient, and intake performance, in terms of distortion coefficient was investigated by testing a low speed model. R J F

N82-13074# Messerschmitt-Boelkow-Blohm G m b H., Munich (West Germany) Unternehmensbereich Flugzeuge

THE DESIGN AND DEVELOPMENT OF THE TORNADO ENGINE AIR INTAKE

C. P. Stocks (British Aerospace, Warton, England) and N. C. Bissinger *In* AGARD Aerodyn of Power Plant Installation Sep 1981 21 p refs

Avail NTIS HC A22/MF A01

The design and development of the Tornado aircraft supersonic intake is described. Critical aerodynamic design areas are outlined with special emphasis on compatibility. The intakes were designed to satisfy the conflicting requirements of greater than Mach 2 operation and a very wide incidence operating envelope at subsonic speeds. The problem of design loads is reviewed as well as the theory and operation of the automatic control system. Propulsion system behavior in flight and some examples of intake-airframe interaction are described. R J F

N82-13075# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio

INTEGRATION OF ADVANCED EXHAUST NOZZLES

Douglas L. Bowers and James A. Laughrey *In* AGARD Aerodyn of Power Plant Installation Sep 1981 14 p refs

Avail NTIS HC A22/MF A01

Attributes of both axisymmetric and nonaxisymmetric advanced nozzles and their incorporation into an aircraft to improve cruise performance, maneuverability and short takeoff and landing operation are discussed. It was concluded that when used as a trimming device, advanced exhaust nozzles with thrust vectoring can provide significant aircraft cruise drag reduction. The aftbody/nozzle installation for advanced airframes and exhaust nozzles must be approached very carefully to demonstrate an installed drag benefit. For maneuver advanced thrust vectoring exhaust nozzles show advantages at high angle of attack. Improved turn rate and instantaneous maneuver performance can be provided by utilizing these advanced exhaust nozzles in advanced aircraft. For short takeoff and landing aircraft advanced exhaust nozzles with both thrust vectoring and thrust reversing may be necessary. Thrust vectoring up to 60 degrees (or higher) and a propulsive lift control system may be required. R J F

N82-13076# Rolls-Royce Ltd., Bristol (England) Installation Aerodynamics Group

THE SUBSONIC PERFORMANCE OF PRACTICAL MILITARY VARIABLE AREA CONVERGENT NOZZLES

L. R. Harper IN AGARD Aerodyn of Power Plant Installation Sep 1981 11 p refs

Avail NTIS HC A22/MF A01

Performance considerations involved in the selection of a variable area nozzle for reheated engines for combat aircraft are discussed. The main emphasis is on dry operation at subsonic speeds since drag, weight, leakage and other penalties in this regime can prevent an aircraft attaining its design radius of action. Zero-base nozzles are compared with a moving shroud nozzle which has a substantial annular base area in dry setting. The moving shroud nozzle, as used on the RB199 engine in the Tornado MRCA, is very competitive with zero base nozzles in terms of overall performance. It is light, mechanically simple, reliable and its short length permits a target type thrust reverser to be used. It is concluded that this type of nozzle is the optimum choice for combat aircraft until further technology advances permit substantial improvements in the overall performace of the more sophisticated nozzles. R J F

N82-13077# Motoren- und Turbinen-Union Muenchen G m b H (West Germany)

COMPARISON OF DIFFERENT NOZZLE CONCEPTS FOR A REHEATED TURBOFAN

H. Grieb, R. Vedova, H. Enderle, and H. Nagel *In* AGARD Aerodyn of Power Plant Installation Sep 1981 15 p refs Sponsored in part by German Ministry of Defence

Avail NTIS HC A22/MF A01

Several concepts of convergent and convergent/divergent nozzles are investigated and compared in view of performance, weight, complexity and the influence on afterbody drag of combat aircraft. The influence of different nozzle cooling concepts on thrust, with subsequent cooling air requirements, is investigated. The optimum ratio of exit area/throat area of convergent/divergent nozzles dependent on nozzle concept and nozzle pressure ratio

is identified The performance comparison shows that fully variable convergent/divergent nozzles promise some advantages against the simple convergent nozzle at high nozzle pressure ratios However, the higher weight and complexity of convergent/divergent nozzles lead to the conclusion that the choice of convergent/divergent nozzles for reheated turbofan engines in combat aircraft is not generally justified J D H

N82-13078# Air Force Wright Aeronautical Labs, Wright-Patterson AFB, Ohio Aero Propulsion Lab
ADVANCED EXHAUST NOZZLE TECHNOLOGY
Ronald J Glidewell and Robert E Warburton (Pratt and Whitney Aircraft Group, West Palm Beach, Fla) *In* AGARD Aerodyn of Power Plant Installation Sep 1981 11 p refs

Avail NTIS HC A22/MF A01

Turbine engine exhaust nozzle technology including nonaxisymmetric nozzles, thrust reversing, and thrust vectoring was investigated Trade studies to determine the impact of these developments on the thrust-to-weight ratio and specific fuel consumption of an advanced high performance, augmented turbofan engine are reported Results are presented in a manner which provides a understanding of the sources and magnitudes of differences in the basic elements of nozzle internal performance and weight as they relate to conventional axisymmetric nozzle technology These comparisons are presented for three categories of nozzle functional capability jet area and exit area control, thrust reversing, and thrust vectoring J D H

N82-13082# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France)
AN ACQUISITION AND ANALYSIS SYSTEM FOR DYNAMIC TESTS OF AIR INLETS [SYSTEME D'ACQUISITION ET D'ANALYSE POUR ESSAIS DYNAMIQUES D'ENTREES D'AIR]
Pierre Perrier, Bertrand Delahaye (SNWCMA, Moissy Cramayel France) and Gerard Laruelle (ONERA Chatillon France) *In* AGARD Aerodyn of Power Plant Installation Aug 1981 14 p refs In FRENCH

Avail NTIS HC A22/MF A01

Improving the flight domain of combat aircraft leads to operations involving a much large variation of unsteady aerodynamic characteristics at the engine inlet than in the past To determine if the augmentation will be effectively acceptable for compressors and engines of the future, sufficient knowledge of flows must be acquired This entails measuring a sufficient number of unsteady flow characteristics, however, the number of measurements made must be limited because of cost as well as because of the possibility of instantaneous or deferred processing This sequence of measurements takes into account necessary compromises Cooperation is needed among the aircraft designer the engine designer, and the research organization so that the work of each can complement that of the others, and an economy of means and a homogeneity of methods for analyzing and interpreting the results is possible Transl by A R H

N82-13084# Fluidyne Engineering Corp , Minneapolis, Minn
MODEL TESTING TECHNIQUES FOR MEASURING INLET DRAG
James S Holdhusen and James L Grunnet *In* AGARD Aerodyn of Power Plant Installation Sep 1981 8 p refs
Avail NTIS HC A22/MF A01

Two methods of measuring inlet drag in transonic flow are described In the first method, a flow through nacelle is tested in a transonic wind tunnel Capture ratio is varied by installing individual annular blockers in the nacelle Corrections for the drag force exerted by the captured streamtube are determined from blow through tests in a static test stand In the second method, drag is determined directly using a special rig which has a variable loss throttle The thrust exiting the control surface is determined by a choked ASME nozzle The advantages and disadvantages of the two methods are compared E A K

N82-13085# National Defence Headquarters, Ottawa (Ontario) Directorate of Science and Technology
COMPRESSOR STALL INDUCING INSTALLATION EFFECTS OF AN ENGINE CONTROL PARAMETER FOR THE CF-5 AIRCRAFT
W L Macmillan, D M Rudnitski, and W Grabe *In* AGARD Aerodyn of Power Plant Installation Sep 1981 17 p Prepared in cooperation with National Research Council of Canada Ottawa

Avail NTIS HC A22/MF A01

Compressor stall problems with CF-5 aircraft powered by two J85-CAN-15 engines were investigated One major cause for compressor stalls as improper operation of the engines' control system under low temperature conditions was identified It is demonstrated that this control system malfunction is the result of engine installation effects which produce an erroneous compressor inlet temperature signal to the main fuel control unit The degree of signal error for several flight conditions such as level flight, high angles of attack, aircraft stalls, and weapons delivery profiles are identified It is found that temperature errors are greater at high angles of attack where severe compressor inlet distortion acts cumulatively in reducing the stall margin under this flight condition E A K

N82-13086# Vereinigte Flugtechnische Werke G m b H Bremen (West Germany)
THE ROLE AND IMPLEMENTATION OF DIFFERENT NACELLE/ENGINE SIMULATION CONCEPTS FOR WIND-TUNNEL TESTING IN RESEARCH AND DEVELOPMENT WORK ON TRANSPORT AIRCRAFT
B Ewald and R Smyth *In* AGARD Aerodyn of Power Plant Installation Sep 1981 35 p refs

Avail NTIS HC A22/MF A01

Different experimental methods and their specific roles in various stages of research and development were investigated The main problem is the simulation and calibration of the propulsion system Different simulation methods are flow through nacelles, powered nacelles (blowing, turbine powered simulators (TPS), ejector powered), inlet models The TPS represent the most advanced simulation of the high bypass ratio engine in model scale A large part of the wind tunnel tests still have to rely upon flow through nacelles A novel flow through nacelle with a variable plug is presented It is shown that the combination of flow through nacelles and TPS can be efficiently used in the windtunnel investigation of propulsion system effects for transport aircraft E A K

N82-13087# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)
WIND TUNNEL TESTS OF POWERED MODELS A COMPARISON OF TWO METHODS OF SIMULATING THE JETS OF JET ENGINES [ESSAIS EN SOUFFLERIE DE MAQUETTES MOTORISEES, COMPARAISON DE DEUX METHODES DE SIMULATION DES JETS DES REACTEURS]
J P Becle and R Perin (SNIAS Toulouse) *In* AGARD Aerodyn of Power Plant Installation Sep 1981 18 p ref In FRENCH

Avail NTIS HC A22/MF A01

Two methods for simulating engine jets were developed at ONERA The so-called blowing jets were previously mounted for studying the Concorde The second method which uses small air breathing turbines was recently installed for Airbus family aircraft Tests were conducted on semi-models mounted on a balance with six components traversed by the flow from the engine An original mounting permits the same measurement means to be used for any principle of power or type of test used (fixed point or wind tunnel test) The installations means of measurement, and methods of using the results are described The respective advantages of each type of power simulation are considered from the viewpoints of complexity duration and precision of measurements obtained Transl by A R H

N82-13088# Aircraft Research Association Ltd Bedford (England)
WIND TUNNEL TEST AND ANALYSIS TECHNIQUES USING POWERED SIMULATORS FOR CIVIL NACELLE INSTALLATION DRAG ASSESSMENT
A E Harris and E C Carter *In* AGARD Aerodyn of Power Plant Installation Sep 1981 16 p refs

Avail NTIS HC A22/MF A01

Full span and semi-span wind tunnel model tests and powered nacelle calibration techniques are discussed in the context of civil nacelle installation drag assessment and optimization In order to achieve the accuracy required for drag analysis it is necessary to determine the installed net thrust of the powered nacelle simulator to the equivalent of at least one aircraft drag count This implies stringent control of mass flow and thrust

accounting and imposes the need for consistency of approach in the wind-on and calibration tests where thrust and mass flow coefficients must be known to 0 1% to 0 2% accuracy This need for high confidence in the data at all stages of analysis led to a methodology in which the measured data is combined in various ways to enhance confidence in its final use Experiences obtained in the use of a Mach simulation tank (MST) for the calibration of turbine powered simulator units are discussed The MST is used to obtain simultaneous mass flow and thrust calibrations with representative internal nacelle conditions in the presence of a quiescent exhaust environment Practical problems associated with the design of balance and airfeed arrangements are discussed along with the use of blown and turbine powered simulators B W

N82-13089# Rolls-Royce Ltd , Derby (England)
ESTABLISHMENT OF AN EXPERIMENTAL TECHNIQUE TO PROVIDE ACCURATE MEASUREMENT OF THE INSTALLED DRAG OF CLOSE COUPLED CIVIL NACELLE/AIRFRAME CONFIGURATIONS, USING A FULL SPAN MODEL WITH TURBINE POWERED ENGINE SIMULATORS
G Pugh and A E Harris (Aircraft Research Association Ltd , Bedford, England) *In* AGARD Aerodyn of Power Plant Installation Sep 1981 9 p refs

Avail NTIS HC A22/MF A01

Definition and optimization of installed thrust/drag in civil nacelle installation design and development was studied As a means of validating the calibration and thrust/drag analysis techniques bodied transport, Lockheed L1011, having high bypass ratio RB 211 turbofan engines with two alternative exhaust system designs was used Wind tunnel model representation comprised a full span simulation with underwing mounted turbine powered engine simulators Calibration techniques included the use of a Mach simulation tank in which concurrent mass flow and thrust calibrations were conducted in a quiescent exhaust environment Data presented includes nacelle thrust and discharge coefficients, installed drag comparisons, and, finally, model to flight correlations B W

N82-13090# National Aerospace Lab , Amsterdam (Netherlands)
EVALUATION OF AN EXPERIMENTAL TECHNIQUE TO INVESTIGATE THE EFFECTS OF THE ENGINE POSITION ON ENGINE/PYLON/WING INTERFERENCE
J A J vanEngelen, B Munniksma, and A Elsenaar *In* AGARD Aerodyn of Power Plant Installation Sep 1981 13 p refs

Avail NTIS HC A22/MF A01

A flexible experimental technique to study the effect of a variation of engine position for a range of test conditions was evaluated In this test an underwing mounted 3/4 fancowl engine was investigated at six different positions as a free flow nacelle and as a strut mounted blown nacelle Pressure and balance force measurements were made Some typical aspects of the aerodynamic interference are discussed, notably the value of free flow nacelle measurements Also a comparison of balance weighed and integrated pressure forces is presented Results indicate that accurate simulation of the engine nozzle geometry is of prime importance for an investigation concerning engine/airframe integration Nevertheless, tests on a free flow nacelle may still be useful for the selection of the most favourable engine position A reasonable correlation was established between interference forces as obtained from pressure integration and balance measurements However, the pressure forces tend to underestimate the balance forces For a flexible pathfinder test, interference forces derived from pressure integration only appear to be very useful for the determination of trends in interference effects B W

N82-13091# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)
STUDIES OF AIR INLETS AT REYNOLDS NUMBERS COMPARABLE TO FLIGHT IN ONERA'S F1 AND S1MA WIND TUNNELS [ESSAIS DE PRISES D'AIR A DES NOMBRES DE REYNOLDS COMPARABLES AU VOL DANS LES SOUFFLERIES F1 ET S1MA DE L'ONERA]
J Leynaert *In* AGARD Aerodyn of Power Plant Installation Sep 1981 12 p refs In FRENCH

Avail NTIS HC A22/MF A01

The pressurization of the subsonic F1 wind tunnel at ONERA's Fauga-Mauzac Center was a benefit in wind tunnel tests of the air intakes of Airbus-type aircraft on a large scale at a Reynolds number near that of flight The same model can thus be tested up to a Mach number near 1 in the S1MA wind tunnel at the Modane Center Air intakes of military aircraft can likewise be studied in the two wind tunnels at high Reynolds numbers The apparatus used the methods of measurement, and the means of calibrating and control used to assure valid results are presented Transl by A R H

N82-13092# British Aerospace Aircraft Group, Hertfordshire (England) Research Dept
THE INFLUENCE OF CLOSED-COUPLED, REAR FUSELAGE MOUNTED NACELLES ON THE DESIGN OF AN ADVANCED HIGH SPEED WING
R D Laugher *In* AGARD Aerodyn of Power Plant Installation Sep 1981 17 p refs

Avail NTIS HC A22/MF A01

The design approach aimed at integrating the effect of the nacelle into the basic wing design is described Particular attention is drawn to the design risk associated with the modified inner wing supercritical flow development when nacelles are not represented in the transonic design calculations Experimental test results are described which demonstrate the general success of the design technique Finally, some results are presented from theoretical investigations in which an attempt was made to simulate the interference effect of the nacelle on the wing supercritical flowfield A technique was developed whereby the nacelle and intake streamtube are replaced by an equivalent interfering body, which is derived from subcritical flow interference pressures Results show that this technique provides a simple, cost effective tool for the supercritical design of a wing operating in the influence of a rear nacelle M D K

N82-13093# Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost Aerodynamics Dept
AERODYNAMIC ASPECTS OF A HIGH BYPASS RATIO ENGINE INSTALLATION ON A FUSELAGE AFTERBODY
N Voogt, J vanHengst, and J Th v d Kolk (NRL) *In* AGARD Aerodyn of Power Plant Installation Sep 1981 10 p refs

Avail NTIS HC A22/MF A01

The design process used in shaping rear fuselage mounted large diameter engine nacelles, pylons, and fuselage for a transport type aircraft is described The objective was to suppress the local velocity levels and pressure gradients to avoid aerodynamic interference drag of the nacelle-pylon-fuselage combination in high speed cruise flight Shapes of fuselage afterbody, nacelle, and stubwing were modified in a design-by-analysis process involving iterative and three dimensional singularity methods for inviscid subsonic flow Windtunnel tests confirmed the adequacy of these methods M D K

N82-13094# Societe Nationale Industrielle Aerospatiale, Toulouse (France) Service Aerodynamique Theorique
A NUMERICAL METHOD FOR STUDYING NACELLE-JET-AIRFOIL INTERACTION IN INVISCID THREE-DIMENSIONAL FLOW [UNE METHODE NUMERIQUE POUR L'ETUDE DE L'INTERACTION NACELLE-JET-VOILURE EN ECOULEMENT TRIDIMENSIONEL NON VISQUEUX]
G LeGall, J Bousquet, and M Yermia *In* AGARD Aerodyn of Power Plant Installation Sep 1981 13 p refs In FRENCH

Avail NTIS HC A22/MF A01

The nacelle-jet-airfoil interaction is a complex three dimensional phenomena which is addressed in two simplified hypotheses the fluid is incompressible and inviscid Under these two hypotheses the propulsive configuration is modeled by air intake with flow control and a propulsive jet with control of the pressure generator A method of singularities is used which considers the sources and doublets of constant density and doublets of linear density on a flat panel The equations which govern the problem constitute a nonlinear system which is divided into a linear part and a quadratic part These two parts are solved iteratively by the Gauss-Seidel method and the Newton method The free boundaries of the flow are also calculated by an iterative process which is integrated into the two preceding methods Some practical results are proposed in two and three dimensional

flow Comparison with tests permits evaluation of the advantage of the simplified hypotheses Transl by A R H

N82-13095# Vereinigte Flugtechnische Werke G m b H , Bremen (West Germany)
CALCULATION OF WING-BODY-NACELLE INTERFERENCE IN SUBSONIC AND TRANSONIC POTENTIAL FLOW
K D Klevenhusen H Jakob, and H Struck *In* AGARD Aerodyn in Power Plant Installation Sep 1981 8 p refs

Avail NTIS HC A22/MF A01
A calculation method especially for transport aircraft wing design with consideration of wing/body or engine/airframe interference was developed A hybrid method, consisting of a combination of panel method and finite difference method is an improvement of a well proved analogy method The panel method is of higher order using linear source and doublet distributions The transonic flow region is removed from the entire flow field and the panel method is used for calculating boundary values for the subsequent finite difference method The finite difference method solves the full potential equation in streamline coordinates E A K

N82-13096*# Boeing Military Airplane Development, Seattle, Wash
PREDICTION OF SUBSONIC AIRCRAFT FLOWS WITH JET EXHAUST INTERACTIONS
D W Roberts *In* AGARD Aerodyn of Power Plant Installation Sep 1981 12 p refs

(Contract NAS2-10100)
Avail NTIS HC A22/MF A01 CSCL 02A
A numerical procedure to calculate the flow fields resulting from the viscous inviscid interactions that occur when a strong jet exhaust and aircraft flow field coupling exists was developed The approach divides the interaction region into zones which are either predominantly viscous or inviscid The flow in the inviscid zone which surrounds most of the aircraft is calculated using an existing potential flow code The viscous flow zone, which encompasses the jet plume, is modeled using a parabolized Navier-Stokes code The procedure features the coupling of the zonal solutions such that sufficient information is transferred between the zones to preserve the effects of the interactions The zonal boundaries overlap and the boundary conditions are the information link between zones An iteration scheme iterates the coupled analysis until convergence has been obtained E A K

N82-13097# Douglas Aircraft Co , Inc , Long Beach, Calif
PROP-FAN INTEGRATION AT CRUISE SPEEDS
H Robert Welge *In* AGARD Aerodyn of Power Plant Installation Sep 1981 14 p refs

Avail NTIS HC A22/MF A01
The aerodynamic installation features of a highly loaded turboprop (prop fan) on an aircraft for flight at Mach 0 8 are discussed The aerodynamic flow environment in which the prop fan must operate is shown for both wing and aft-fuselage installations using advanced surface panel methods The effects of prop fan slipstream parameters on the drag of a supercritical wing are presented indicating that only small drag penalties occur Drag reductions are possible by tailoring the local wing section to account for the rotor induced flow Using these inputs, an integrated wing/nacelle is shown E A K

N82-13098*# Boeing Commercial Airplane Co , Seattle, Wash New Product Development Dept
AIRFRAME-PROPULSION SYSTEM AERODYNAMIC INTERFERENCE PREDICTIONS AT HIGH TRANSONIC MACH NUMBERS INCLUDING OFF-DESIGN ENGINE AIRFLOW EFFECTS
R M Kulfan and A Sigalla *In* AGARD Aerodyn of Power Plant Installation Sep 1981 23 p refs

(Contract NAS1-14623)
Avail NTIS HC A22/MF A01 CSCL 02A
The transonic speed regime for airplanes at conditions where inlet spillage takes place is discussed A wind tunnel test program to evaluate aerodynamic performance penalties associated with propulsion system installation and operation at subsonic through low supersonic speeds was conducted The accuracy of analytic methods for predicting transonic engine airframe interference effects was assessed Study variables included Mach number, angle of attack, relative celle location, and nacelle mass flow ratio Results include test theory comparisons of forces as well as induced pressure fields Prediction capability of induced shock wave strength and locations is assessed It was found that large interference forces due to engine location and flow spillage occur at transonic speeds, that theory explains these effects, and that theory can predict quantitatively these effects E A K

N82-13104 Iowa Univ Oakdale
TURBULENT WAKE DEVELOPMENT BEHIND STREAMLINED BODIES ***Ph D Thesis***
Sastry Suryanarayana Munukutla 1981 316 p
Avail Univ Microfilms Order No 8123346
The developing turbulent wake behind streamlined bodies is reported Detailed measurements of mean and turbulent flow properties are made in three different wake flows The first is the symmetric wake of a flat plate, the second is the asymmetric wake of a flat plate, (asymmetry being produced by roughening on side of the plate) and the third is the curved wake of an asymmetric airfoil at incidence It is possible to identify three important regions in the wake, namely the near wake, intermediate wake and the far wake The performance of the existing turbulence models in the case of the symmetric flat plate wake is studied The near and intermediate wake regions are predicted by a sophisticated turbulence model Dissert Abstr

N82-13106*# National Aeronautics and Space Administration Langley Research Center Hampton, Va
FORCE AND MOMENT, FLOW-VISUALIZATION, AND BOUNDARY-LAYER TESTS ON A SHUTTLE ORBITER MODEL AT MACH 6
Robert L Calloway Dec 1981 25 p refs
(NASA-TP-1952, L-14782) Avail NTIS HC A02/MF A01 CSCL 01A
Force and moment, flow visualization, and boundary layer state tests were conducted using two 0 004 scale shuttle orbiter models The force and moment tests were conducted for an angle of attack range from 20 to 40 deg and for Reynolds numbers based on reference length from 0 4 million to 3 6 million Schlieren photographs were obtained for each angle of attack and Reynolds number The boundary layer state tests, which were conducted using hot film sensors mounted in a separate model, were conducted over the same range of conditions as the force tests Test results were combined to show that changes in the boundary layer on a typical hypersonic force test model affect measurement of the axial force coefficient and that the state of the local boundary layer is important for interpreting hypersonic aerodynamic test results S L

N82-13107*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF BLADE TIP GEOMETRY ON THE INTERACTION OF TORSIONAL LOADS AND PERFORMANCE FOR AN ARTICULATED HELICOPTER ROTOR
William T Yeager and Wayne R Mantay Dec 1981 64 p refs Prepared in cooperation with Army Aviation Research and Development Command, Hampton, Va
(DA Proj 1L2-62209-AH-76)
(NASA-TP-1926, AVRADCOM-TR-81-B-5 L-14674) Avail NTIS HC A04/MF A01 CSCL 01A
The Langley transonic dynamics tunnel was used to determine the degree of correlation between rotor performance and the dynamic twist generated by changes in blade tip geometry using an articulated rotor with four different tip geometries at advance ratios of 0 20, 0 30 and 0 35 Based on the data obtained, it is concluded that (1) there appears to be no strong correlation between blade torsion loads and rotor performance prediction, (2) for a given rotor task at each advance ratio investigated, both the azimuthal variation of torsional moment and the mean torsional moment at 81% radius are configuration dependent, (3) reducing the nose down twist on the advancing blade appears to be more important to forward flight performance than increasing the nose down twist on the retreating blade, (4) the rotor inflow model used was important in predicting the performance of the adaptive rotor, and (5) neither rigid blade solidity effects, inflow environment, nor blade torsion loads can be used alone to accurately predict active rotor performance A R H

N82-13109# National Aerospace Lab , Tokyo (Japan)
AN AERODYNAMIC DESIGN AND THE OVERALL STAGE

PERFORMANCE OF AN AIR-COOLED AXIAL-FLOW TURBINE

Atsumasa Yamamoto Kitao Takahara Hiroyuki Nouse, Shigeo Inoue, Hiroshi Usui, and Fugio Mimura Jan 1981 44 p refs (NAL-TR-321T) Avail NTIS HC A03/MF A01

In order to investigate air-cooled turbines for application to high-temperature engines, a single stage turbine with a 0 56-m (22-inch) tip diameter was designed The aerodynamical design procedures of the turbine are presented The stator and rotor blades are characterized by low blade solidity, thick blade section, blunt leading edge and trailing edge and low blade aspect ratio A cold air test without supply of cooling air was conducted to determine the turbine aerodynamic performance The highest efficiency obtained over the range of conditions investigated was 0 865 The turbine satisfied the equivalent design value of specific work output at the design condition (i e , at equivalent design speed and equivalent design pressure ratio) with an efficiency of 0 856 Detailed surveys of rotor-outlet gas flow were made with Pitot tubes and temperature sensors and the results are also presented T M

N82-13110*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va

PRESSURE DISTRIBUTIONS ON THREE DIFFERENT CRUCIFORM AFT-TAIL CONTROL SURFACES OF A WINGLESS MISSILE AT MACH 1.60, 2.36, AND 3 70 VOLUME 1· TRAPEZOIDAL TAIL

Milton Lamb Wallace C Sawyer, Donald L Wassum, and C Donald Babb Aug 1979 345 p

(NASA-TM-80097 L-12993-Vol-1) Avail NTIS HC A15/MF A01 CSCL 01A

The results of pressure distribution tests conducted in a wind tunnel are presented without analysis The data were obtained for trapezoidal aft tail control surfaces on a wingless missile model at Mach numbers of 1 60, 2 36, and 3 70 for angles of attack from -4 to 20 deg model roll angles from 0 to 90 deg and tail deflections of 0 and -15 deg The test Reynolds number used was 6 6 million per meter M D K

N82-13112*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

THRUST MODULATION METHODS FOR A SUBSONIC V/STOL AIRCRAFT

Richard R Woollett 1981 18 p refs Presented at V/STOL Conf , Palo Alto, Calif , 7-9 Dec 1981 sponsored by AIAA and NASA Ames

(NASA-TM-82747 E-1063) Avail NTIS HC A02/MF A01 CSCL 01A

Low speed wind tunnel tests were conducted to assess four methods for attaining thrust modulation for V/STOL aircraft The four methods were (1) fan speed change, (2) fan nozzle exit area change, (3) variable pitch rotor (VPR) fan, and (4) variable inlet guide vanes (VIGV) The interrelationships between inlet and thrust modulation system were also investigated using a double slotted inlet and thick lip inlet Results can be summarized as (1) the VPR and VIGV systems were the most promising, (2) changes in blade angle to obtain changes in fan thrust have significant implications for the inlet and (3) both systems attained required level of thrust with acceptable levels of fan blade stress M D K

N82-13115# Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)

A CALCULATION METHOD FOR SLENDER WING-BODY CONFIGURATIONS IN SUPERSONIC FLOW AT HIGH ANGLES OF ATTACK [EIN BERECHNUNGSVERFAHREN FUER SCHLANKE FLUEGEL-RUMPFANORDNUNGEN IM UEBERSCHALL BEI HOHEN ANSTELLWINKELN]

D Nikolitsch Bonn Bundesministerium der Verteidigung 1979 58 p refs In GERMAN ENGLISH summary Sponsored by Bundesministerium der Verteidigung

(BMVg-FBWT-79-15) Avail NTIS HC A04/MF A01, DOK-ZENTBw, Bonn DM 30

An analysis which determines nonlinear force and pitching moment characteristics of slender bodies and slender wing-body configurations at high angles of attack in supersonic flow is presented The linear coefficients of the body are calculated by means of a singularity distribution along the body axis The nonlinear coefficients are determined by a method based on Wardlaw's multivortex model which is modified so that it is applicable at Mach > 1 The wing characteristics are calculated with the Huerlimann prediction method this method is limited to slender, tapered wing planforms The mutual interference of wing and body is accounted for by Nielsen interference factors The range of application of the analysis is exemplified by sample calculations Author (ESA)

N82-13116# Messerschmitt-Boelkow-Blohm G m b H , Munich (West Germany) Unternehmensbereich Flugzeuge

FINAL REPORT ON THE FUEFO-4 MAJOR THEME, INTERFERENCE DRAG WITH AIRFRAME/ENGINE INTEGRATION ON FIGHTER AIRCRAFT Final Report [ABSCHLUSSBEREICHT ZUM RUEFO-4 RAHMENTHEMA 'INTERFERENZWIDERSTAND BEI DER ZELLEN-/TREIBWERKSINTEGRATION VON KAMPFFLUGZEUGEN']

H L Weinreich and R Smyth (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) Bonn Bundesministerium der Verteidigung 1979 182 p refs In GERMAN ENGLISH summary Sponsored by Bundesministerium der Verteidigung

(BMVg-FBWT-79-20) Avail NTIS HC A09/MF A01, DOK-ZENTBw, Bonn DM 40

Theoretical and experimental (wind tunnel) studies of engine nozzle characteristics as well as of engine/airframe aerodynamic interaction are summarized Results significant to fighter aircraft configuration optimization are identified Wind tunnel experiment design is also critically assessed Results emphasized concern experimental data for parameters influencing afterbody drag, theoretical and construction concepts of variable CONDI nozzles theoretical methods for the correction of wind tunnel data the synthesis of inlet drag and investigations of jet decay structures Author (ESA)

N82-13131*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

GROUP 1. SCENARIO DESIGN AND DEVELOPMENT ISSUES

Peter Sherwin *In its* Guidelines for Line-oriented Flight Training, Vol 2 1981 p 113-117

Avail NTIS HC A08/MF A01 CSCL 05I

All LOFt scenarios and flight segments should be designed on the basis of a detailed statement of specific objectives These objectives must state what kind of situation is to be addressed and why The origin, routing, and destination of a particular scenario should be dictated by the specific objectives for that scenario or leg Other factors to be considered are the desired weather, climate, etc Simulator visual system, as well as other capabilities and limitations must be considered at a very early stage of scenario design The simulator navigation area must be apropriate and must coincide with current Jeppeson charts Much of the realism of LOFT is destroyed if the crew is unable to use current manuals and other materials A R H

N82-13135# SCI Systems, Inc , Huntsville, Ala

TECHNIQUES FOR INTERFACING MULTIPLEX SYSTEMS Final Report, 10 Sep. 1979 - 10 May 1980

James P Gross Feb 1981 138 p

(Contract F33615-79-C-1878 AF Proj 2003)

(AD-A101457, AFWAL-TR-80-1223) Avail NTIS HC A07/MF A01 CSCL 17/2

Data describing the characteristics of a number of aircraft multiplex systems were collected and compiled Although Air Force aircraft received priority, were consideration was also given to other military and commercial aircraft The F-16, B-52 OAS, YAH-64, F-18, F-15 and ARINC 575 systems were included MIL-STD-1553B was used as a baseline for comparison The compiled data was analyzed to determine points of incompatibility between these systems and a feasibility study was performed to assess possible techniques to be used in achieving bus compatibility A programmable interface module design philosophy is recommended which utilizes a distributed three-microprocessor arrangement to achieve the desired interface compatibility The three-processor conept allows three independent software-controlled events to occur simultaneously, thus providing an extremely high degree of flexibility both for existing systems and for future growth Author

N82-13136# Institute for Defense Analyses, Arlington, Va Program Analysis Div

HELICOPTER RELIABILITY AND MAINTAINABILITY

TRENDS DURING DEVELOPMENT AND PRODUCTION
Final Report
Norman J Asher Lee L Douglas, and Ray H Jakobovits Jul 1981 279 p refs Revised
(Contract MDA903-79-C-0320)
(AD-A105775, AD-E500409, IDA/HQ-81-23636) Avail NTIS HC A13/MF A01 CSCL 01/3

This study updates and extends IDA Study S-451, 'Changes in Helicopter Reliability/Maintainability Characteristics Over Time,' dated March 1975 This study presents more recent data and, based on the combined data of both studies, summarizes the observed helicopter R&M trends Trends observed during the development phase are compared with those of the production phase GRA

N82-13137# Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany) Unternehmensbereich Drehfluegler und Verkehr
SYSTEM IDENTIFICATION HELICOPTER PARAMETERS. DETERMINATION FROM FLIGHT TESTS, PHASE 2 [SYSTEMIDENTIFIZIERUNG DREHFLUEGLER KENNWERT-ERMITTLUNG AUS FLUGMESSUNGEN (PHASE 2)]
M Kloster and S Attlfellner Bonn Bundesministerium der Verteidigung 1980 92 p refs In GERMAN ENGLISH summary Sponsored by Bundesministerium der Verteidigung
(BMVg-FBWT-80-12) Avail NTIS HC A05/MF A01, DOK-ZENTw, Bonn DM 30

A parameter identification program for a hingeless rotor helicopter is considered Flight conditions were selected with increasing instability, i e , hover and level flight at maximum speed, with maximum weight and with a rearward center of gravity A strap down system was chosen to provide the attitude feedback control necessary for proper identification The control input signals were optimized for the unstabilized helicopter Calculations in the time and frequency domains show that special distributions in the power spectrum of the input signals are needed for optimizing the closed loop system The identified derivatives and the smoothened time histories from flight tests are compared with the identification results of linear and nonlinear simulations and of the quasistatic theory Author (ESA)

N82-13138# Vereinigte Flugtechnische Werke G m b H , Bremen (West Germany)
MANEUVER LOAD CONTROL FOR THE REDUCTION OF DESIGN LOADS AND IMPROVEMENT OF THE MANEUVER-ABILITY OF MODERN FIGHTER AIRCRAFT
Horst Balke Bonn Bundesministerium der Verteidigung 1981 283 p refs In GERMAN ENGLISH summary Sponsored by Bundesministerium der Verteidigung
(BMVg-FBWT-81-2) Avail NTIS HC A13/MF A01, DOK-ZENTBw Bonn DM 50

Active control technology is applied and the feasibility of design load reduction is analyzed The influence of direct force control on aircraft component loads and on aircraft maneuverability is seen The deflection of secondary control surfaces in proportion with the commanded control surface was investigated in an open loop control system Load reduction efficiency diagrams and tables are presented A comparison of two different aircraft shows that with an open loop control system a considerable reduction in design load is possible The loads acting on several aircraft components for different open loop control systems are compared Several closed loop control systems with aircraft response feedback parameters were also investigated The results are again presented as diagrams, and tables Only in some cases does closed loop control achieve better results than open loop control The best design load reduction is achieved with a combined open and closed loop control system The investigation results are comprehensively evaluated and the parameters relevant for design load reduction are summarized Author (ESA)

N82-13139 Air Force Systems Command, Wright-Patterson AFB, Ohio Foreign Technology Div
RAVEN AIRCRAFT FILTER-ABSORBER
Jerzy Chojnacki 26 Nov 1980 5 p Transl into ENGLISH from Skrzydlata Polska (Poland), Vol 1, no 51-52, 1979 p 7
(AD-A098962, FTD-ID(RS)T-2017-80) HC A02/MF A01 CSCL 06/11

A filter-absorber in the shape of a rectangular box and weighing 9 5 kg is mounted outside the cockpit of an agricultural aircraft Toxic compounds given off during crop spraying are trapped by internal filters The first, or forward filter has Anilana fibers The second, or actual purification filter, is made from fiberglass which absorbs the finest airborne contaminants The pesticide filter-absorber device is quaranteed for 100 hours of operation and was designed for use in Africa A R H

N82-13140*# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France)
PRACTICAL ASPECTS OF INSTRUMENTATION SYSTEM INSTALLATION, VOLUME 13
R W Borek, A Pool, ed and K C Sanderson, ed Sep 1981 197 p refs
(NASA-TM-84067, AGARD-AG-160-Vol-13, ISBN-92-835-1399-1) Avail NTIS HC A09/MF A01 CSCL 01D

A review of factors influencing installation of aircraft flight test instrumentation is presented Requirements, including such factors as environment, reliability, maintainability, and system safety are discussed The assessment of the mission profile is followed by an overview of electrical and mechanical installation factors with emphasis on shock/vibraion isolation systems and standardization of the electric wiring installation, two factors often overlooked by instrumentation engineers A discussion of installation hardware reviews the performance capabilities of wiring, connectors, fuses and circuit breakers, and a guide to proper selections is provided The discussion of the installation is primarily concerned with the electrical wire routing, shield terminations and grounding Also inclued are some examples of installation mistakes that could affect system accuracy System verification procedures and special considerations such as sneak circuits, pyrotechnics, aircraft antenna patterns, and lightning strikes are discussed M D K

N82-13141# General Electric Co , Binghamton, N Y Aircraft Equipment Div
ELECTRONIC MASTER MONITOR AND ADVISORY DISPLAY SYSTEM TEST AND DEMONSTRATION REPORT
Interim Report, Jan. - Jun 1981
Jun 1981 52 p
(Contract DAAK80-79-C-0270)
(AD-A105317, ACS-12388, AVRADCOM-TR-79-0270-5 IR-5) Avail NTIS HC A04/MF A01 CSCL 01/4

The hardware and software of the electronic master monitor and advisory display system are tested The results are documented and the feasibility of the system is demonstrated Author

N82-13142*# National Aeronautics and Space Administration Langley Research Center, Hampton, Va
NUMERICAL ANALYSIS OF THE SCRAMJET-INLET FLOW FIELD BY USING TWO-DIMENSIONAL NAVIER-STOKES EQUATIONS
Ajay Kumar Dec 1981 30 p refs
(NASA-TP-1940 L-14776) Avail NTIS HC A03/MF A01 CSCL 21E

A computer code was developed to solve the full two dimensional Navier-Stokes equations in a supersonic combustion ramjet (scramjet) inlet In order to be able to consider a general inlet geometry with embedded bodies, a numerical coordinate transformation is used which generates a set of boundary-fitted curvilinear coordinates The explicit finite difference algorithm of MacCormack is used to solve the governing equations An algebraic, two-layer eddy-viscosity model is used for the turbulent flow The code can analyze both inviscid and viscous flows with no strut, one strut, or multiple struts in the flow field The application of the two dimensional analysis in the preliminary parametric design studies of a scramjet inlet is discussed Detailed results are presented for one model problem and for several actual scramjet-inlet configurations R J F

N82-13143*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
EFFECT OF FUEL-AIR-RATIO NONUNIFORMITY ON EMISSIONS OF NITROGEN OXIDES
Valerie J Lyons Nov 1981 14 p refs
(NASA-TP-1798, E-648) Avail NTIS HC A02/MF A01 CSCL 21E

The inlet fuel-air ratio nonuniformity is studied to determe how nitrogen oxide (NOx) emissions are affected An increase in NOx emissions with increased fuel-air ratio nonuniformity for average equivalence ratios less than 0 7 and a decrease in NOx emissions for average equivalence ratios near stoichiometric is predicted The degree of unifomrityy of fuel-air ratio profiles that is necessary to achieve NOx emissions goals for actual engines

that use lean, premixed, prevaporized combustion systems is determined S L

N82-13144*# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio
A REAL TIME PEGASUS PROPULSION SYSTEM MODEL FOR VSTOL PILOTED SIMULATION EVALUATION
James R Mihaloew, Stephen P Roth (Pratt and Whitney Aircraft Group West Palm Beach Fla) and Robert Creekmore (Pratt and Whitney Aircraft Group, West Palm Beach, Fla) 1981 18 p refs Presented at VSTOL Conf, Palo Alto, Calif, 7-9 Dec 1981, sponsored by AIAA and NASA Ames Research Center
(NASA-TM-82770 E-1004, AIAA-81-2663) Avail NTIS HC A02/MF A01 CSCL 21E

A real time propulsion system modeling technique suitable for use in man-in-the-loop simulator studies was developed This technique provides the system accuracy, stability and transient response required for integrated aircraft and propulsion control system studies A Pegasus-Harrier propulsion system was selected as a baseline for developing mathematical modeling and simulation techniques for VSTOL Initially, static and dynamic propulsion system characteristics were modeled in detail to form a nonlinear aerothermodynamic digital computer simulation of a Pegasus engine From this high fidelity simulation a real time propulsion model was formulated by applying a piece-wise linear state variable methodology A hydromechanical and water injection control system was also simulated The real time dynamic model includes the detail and flexibility required for the evaluation of critical control parameters and propulsion component limits over a limited flight envelope The model was programmed for interfacing with a Harrier aircraft simulation Typical propulsion system simulation results are presented M D K

N82-13145*# Pratt and Whitney Aircraft Group East Hartford, Conn Commercial Products Div
SENSOR FAILURE DETECTION SYSTEM Final Report
E C Beattie R F LaPrad, M E McGlone, S M Rock, and M M Akhter Aug 1981 172 p refs Prepared in cooperation with Systems Control Inc Palo Alto Calif
(Contract NAS3-22481)
(NASA-CR-165515 PWA-5736-17) Avail NTIS HC A08/MF A01 CSCL 21E

Advanced concepts for detecting, isolating, and accommodating sensor failures were studied to determine their applicability to the gas turbine control problem Five concepts were formulated based upon such techniques as Kalman filters and a screening process led to the selection of one advanced concept for further evaluation The selected advanced concept uses a Kalman filter to generate residuals, a weighted sum square residuals technique to detect soft failures, likelihood ratio testing of a bank of Kalman filters for isolation and reconfiguring of the normal mode Kalman filter by eliminating the failed input to accommodate the failure The advanced concept was compared to a baseline parameter synthesis technique The advanced concept was shown to be a viable concept for detecting, isolating and accommodating sensor failures for the gas turbine applications M G

N82-13146*# National Aeronautics and Space Administration Lewis Research Center Cleveland, Ohio
NASA RESEARCH IN AIRCRAFT PROPULSION
Milton A Beheim 1982 17 p Proposed for presentation at the 27th Ann Intern Gas Turbine Conf, London 18-22 Apr 1982, sponsored by ASME
(NASA-TM-82771 E-1096) Avail NTIS HC A02/MF A01 CSCL 21E

A broad overview of the scope of research presently being supported by NASA in aircraft propulsion is presented with emphasis on Lewis Research Center activities related to civil air transports CTOL and V/STOL systems Aircraft systems work is performed to identify the requirements for the propulsion system that enhance the mission capabilities of the aircraft This important source of innovation and creativity drives the direction of propulsion research In a companion effort component research of a generic nature is performed to provide a better basis for design and provides an evolutionary process for technological growth that increases the capabilities of all types of aircraft Both are important A R H

N82-13147*# Stanford Univ, Calif Dept of Aeronautics and Astronautics
DESIGN FOR ACTIVE AND PASSIVE FLUTTER SUPPRESSION AND GUST ALLEVIATION Ph D. Thesis
Mordechay Karpel Washington NASA Nov 1981 117 p refs
(Grant NGL-05-020-243)
(NASA-CR-3482) Avail NTIS HC A06/MF A01 CSCL 01C

Analytical design techniques for active and passive control of aeroelastic systems are based on a rational approximation of the unsteady aerodynamic loads in the entire Laplace domain which yields matrix equations of motion with constant coefficients Some existing schemes are reviewed, the matrix Pade approximant is modified and a technique which yields a minimal number of augmented states for a desired accuracy is presented The state-space aeroelastic model is used to design an active control system for simultaneous flutter suppression and gust alleviation The design target is for a continuous controller which transfers some measurements taken on the vehicle to a control command applied to a control surface Structural modifications are formulated in a way which enables the treatment of passive flutter suppression system with the same procedures by which active control systems are designed A R H

N82-13148*# National Aeronautics and Space Administration Langley Research Center, Hampton Va
LIMITED EVALUATION OF AN F-14A AIRPLANE UTILIZING AN AILERON-RUDDER INTERCONNECT CONTROL SYSTEM IN THE LANDING CONFIGURATION
Wendell W Kelley and Einar K Enevoldson (NASA Dryden Flight Research Center) Dec 1981 39 p refs
(NASA-TM-81972, L-14756) Avail NTIS HC A03/MF A01 CSCL 01C

A flight test was conducted for preliminary evaluation of an aileron-rudder interconnect (ARI) control system for the F-14A airplane in the landing configuration Two ARI configurations were tested in addition to the standard F-14 flight control system Results of the flight test showed marked improvement in handling qualities when the ARI systems were used Sideslip due to adverse yaw was considerably reduced, and airplane turn rate was more responsive to pilot lateral control inputs Pilot comments substantiated the flight data and indicated that the ARI systems were superior to the standard control system in terms of pilot capability to make lateral offset corrections and heading changes on final approach Author

N82-13149*# National Aeronautics and Space Administration Hugh L Dryden Flight Research Center, Edwards, Calif
ANALYSIS OF A LONGITUDINAL PILOT-INDUCED OSCILLATION EXPERIENCED ON THE APPROACH AND LANDING TEST OF THE SPACE SHUTTLE
John W Smith Dec 1981 45 p refs
(NASA-TM-81366) Avail NTIS HC A03/MF A01 CSCL 05H

During the final free flight (FF-5) of the shuttle s approach and landing tests, the vehicle experienced pilot-induced oscillations near touchdown The light test data showed that pilot inputs to the hand controller reached peak-to-peak amplitudes of 20 deg at a frequency between 3 and 3 5 radians per second The controller inputs were sufficient to exceed the priority rate limit set in the pitch axis A nonlinear analytical study was conducted to investigate the combined effects of pilot input, rate limiting, and time delays The frequency response of the total system is presented parametrically as a function of the three variables In general, with no dead time, for controller inputs of 5 deg or less, the total system behaves in a linear fashion For 10 deg of controller input independent of the delay time the elevon loop will be rate saturated above a frequency of 4 radians per second Author

N82-13150*# Purdue Univ Lafayette Ind School of Aeronautics and Astronautics
INTERACTIVE AIRCRAFT FLIGHT CONTROL AND AEROELASTIC STABILIZATION Interim Report
Terrence A Weisshaar and David K Schmidt 31 Oct 1981 39 p refs
(Grant NAG1-157)
(NASA-CR-165036) Avail NTIS HC A03/MF A01 CSCL 01C

Several examples are presented in which flutter involving interaction between flight mechanics modes and elastic wind bending occurs for a forward swept wing flight vehicle These results show the basic mechanism by which the instability occurs

and form the basis for attempts to actively control such a vehicle A R H

N82-13186*# San Jose State Univ , Calif
DEVELOPMENT AND TESTING OF DRY CHEMICALS IN ADVANCED EXTINGUISHING SYSTEMS FOR JET ENGINE NACELLE FIRES Final Report
Robert L Altman, A Campbell Ling, ed , Ludwig A Mayer, and Donald J Myronik Sep 1979 314 p
(Grant NsG-2165)
(NASA-CR-165011) Avail NTIS HC A14/MF A01 CSCL 21B

The effectiveness of dry chemical in extinguishing and delaying reignition of fires resulting from hydrocarbon fuel leaking onto heated surfaces such as can occur in jet engine nacelles is studied The commercial fire extinguishant dry chemical tried are sodium and potassium bicarbonate, carbonate, chloride, carbamate (Monnex), metal halogen, and metal hydroxycarbonate compounds Synthetic and preparative procedures for new materials developed, a new concept of fire control by dry chemical agents, descriptions of experiment assemblages to test dry chemical fire extinguishant efficiencies in controlling fuel fires initiated by hot surfaces, comparative testing data for more than 25 chemical systems in a static assemblage with no air flow across the heated surface, and similar comparative data for more than ten compounds in a dynamic system with air flows up to 350 ft/sec are presented S L

N82-13442 Purdue Univ Lafayette, Ind
MEASURED PAVEMENT RESPONSE TO TRANSIENT AIRCRAFT LOADINGS Ph.D Thesis
Thomas Dale White 1981 243 p
Avail Univ Microfilms Order No 8123723

Pavement deformation response to aircraft traffic was studied Linear variable differential transducers (LVDT's) were installed in an active taxiway The LVDT s were attached to reference rods anchored at 16, 36, 120 and 209 in Basic pavement responses information on how pavement layers accommodate dynamic loads, as well as data to compare vertical deformations predicted by a theoretical model were examined A finite difference solution was used to predict pavement temperatures The solution is shown to have limited application for predicting pavement temperatures The pavement response phenomena reported are significant They expose pavement responses that have been minimized in past research but must now be considered Current theoretical models used in pavement analysis or design are limited in predicting pavement response phenomena They do not represent the observed compression and extension in a pavement under and away from actual aircraft loads
Dissert Abstr

N82-13457# Dornier-Werke G m b H Friedrichshafen (West Germany)
STRUCTURAL DYNAMICS. MODIFIED CALCULATIONS
G Hornung and H Roehrle Bonn Bundesministerium der Verteidigung 1981 83 p refs In GERMAN, ENGLISH summary Sponsored by Bundesministerium der Verteidigung
(BMVg-FBWT-81-1) Avail NTIS HC A05/MF A01, DOK-ZENTBw, Bonn DM 30

Calculation methods which give natural and harmonically excited vibrations of modified structures, using the results of the original systems, are presented and tested Most of the methods are based on a linear approximation, i e , the individual terms of the equations of motion are subdivided into those of the original system and into corresponding difference terms whose products are subsequently neglected Tests are carried out for simple models as well as for three-dimensionally idealized wing and aircraft structures Concerning natural vibrations, it is difficult to estimate the achieved accuracy without knowing the exact results The applied methods are Wielandt iteration and subspace iteration Using the original natural modes as starting vectors leads to a considerable reduction in computation cost, even with severe modifications Application of the linear approximation is shown for the reduction of the number of degrees of freedom, which precedes dynamic analysis *Author (ESA)*

N82-13813 Tennessee Univ , Knoxville
PREDICTION OF AERODYNAMIC LOADS ON AIRCRAFTS WITH EXTERNAL STORES AT TRANSONIC SPEEDS Ph D. Thesis
Chandrasekaran Balasubramanyan 1981 204 p
Avail Univ Microfilms Order No 8123139

The Integral equation method was applied to calculate the pressure distribution over an arbitrary, three dimensional lifting wing and a three dimensional wing with an external store, kept beneath the wing A method to calculate the interference effects imposed by an external store on the wing and vice-versa is given The wing along transonic solution is analyzed and compared with the experimental results and as well as a wing with an external store A theory for the flow field nonlinear velocity prediction is developed, programmed, and applied to a wing with an external store configuration and the flow field velocities are compared with the experimental results The numerical methods for solving the triple and double integrals with limits to infinity are studied and the application of one such method to the flow field prediction problem is briefly indicated Further extension of this work is indicated with the limitations and advantages *Dissert Abstr*

N82-13835# Rockwell International Corp , Columbus Ohio North American Aircraft Div
INVESTIGATION OF ACOUSTIC INTERACTIONS IN JET THRUST AUGMENTING EJECTORS *Final Report, 1 Jan. 1979 - 30 Sep. 1980*
J R Campbell, K D Korkan (Ohio State Univ , Columbus), and H Viets (Wright State Univ) 5 Mar 1981 244 p refs
(Contract N00019-79-C-0225)
(AD-A106083, NR80H-50) Avail NTIS HC A11/MF A01 CSCL 20/1

The performance of a constant area rectangular ejector with varying mixing length was investigated to determine the aeroacoustic interaction effects The rectangular ejector investigation was conducted in two phases The phase one investigation involved the testing of three different aspect ratio rectangular convergent nozzles at pressures between 15-45 psig to determine the acoustic and jet spreading characteristics From these data a rectangular ejector incorporating endwall and ejector flap blowing was fabricated and investigated at pressure ratios between 2 0 and 5 0 These investigations were conducted at ejector flap length (L) to ejector throat widths (W), L/W of 11 0, 9 5, 8 0, 6 5, 5 0, 3 5, 2 0, and 0 9 to determine the ejector performance The data for the rectangular ejector configuration investigated showed an aeroacoustic interaction in the present ratio range of 3 3 - 3 8 However, the resulting performance was not improved to the degree experienced with axisymmetric ejectors
Author (GRA)

N82-13908*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
EFFECT OF VACUUM EXHAUST PRESSURE ON THE PERFORMANCE OF MHD DUCTS AT HIGH D-FIELD
J Marlin Smith, J L Morgan, and Shih-Ying Wang 1982 13 p refs Presented at the 20th Aerospace Sci Meeting, Orlando, Fla , 11-14 Jan 1982 sponsored by AIAA
(Contract DE-AI01-77ET-10769)
(NASA-TM-82750 DOE/NASA/10769-23, F-1066) Avail NTIS HC A02/MF A01 CSCL 20I

The effect of area ratio variation on the performance of a supersonic Hall MHD duct is investigated Results indicate that for a given combustion pressure there exists an area ratio below which the power generating region of the duct is shock free and the power output increases linearly with the square of the magnetic field For area ratios greater than this, a shock forms in the power generating region which moves upstream with increasing magnetic field strength resulting in a less rapid raise in the power output The shock can be moved downstream by either increasing the combustion pressure of decreasing the exhaust pressure The influence of these effects upon duct performance is presented 8 W

N82-13974# Naval Postgraduate School, Monterey, Calif
COMPILATION OF ABSTRACTS OF DISSERTATIONS THESES, AND RESEARCH PAPERS SUBMITTED BY CANDIDATES FOR DEGREES, 1 OCTOBER 1979 - 30 SEPTEMBER 1980
Mar 1981 514 p
(AD-A104124, NPS-012-81-002PR) Avail NTIS HC A22/MF A01 CSCL 05/2

Abstracts are presented of works submitted in fulfillment of degree requirements in the area of aeronautical, electrical, and mechanical engineering as well as in applied mathematics, applied sciences, and computer sciences *Author*

N82-13975# Naval Postgraduate School, Monterey, Calif
A SUMMARY OF THE NAVAL POSTGRADUATE SCHOOL RESEARCH PROGRAM Summary Report, 1 Oct. 1979 - 30 Sep. 1980
Apr 1981 528 p
(AD-A104112, NPS-012-81-003PR) Avail NTIS HC A23/MF A01 CSCL 05/2

Two hundred thirty research projects are summarized in the following areas computer science, mathematics, administrative sciences, defense resources management, operations research, national security affairs, physics and chemistry, electrical engineering meteorology aeronautics, oceanography, and mechanical engineering Author

N82-13979# RAND Corp., Santa Monica, Calif
A NEW APPROACH TO MODELING THE COST OF OWNERSHIP FOR AIRCRAFT SYSTEMS Interim Report
K E Marks, H G Massey, B D Bradley, and J Lu Aug 1981 151 p refs
(Contract F49620-77-C-0023)
(AD-A104434, RAND/R-2601-AF) Avail NTIS HC A08/MF A01 CSCL 05/1

Support investment costs and recurring operations and support costs are through determined using a model for estimating aircraft cost of ownership (MACO), which also provides a framework for future research An outgrowth of an earlier evaluation of the strengths and weaknesses of the most widely used aircraft life cycle cost models, MACO combines algorithms for major, maintenance related costs with formulas drawn from existing models for other cost elements A full set of ownership cost elements is related to component level reliability and maintainability characteristics and to aircraft design, operations, logistics, and deployment parameters Resource quantities are computed in units that can be related directly to Air Force programming categories, including base maintenance manning (by work center), depot manning, and recoverable spares inventory levels Output and input parameters accommodate annual changes in system parameters and operating conditions such as component reliability and aircraft inventory size and activity rates Author

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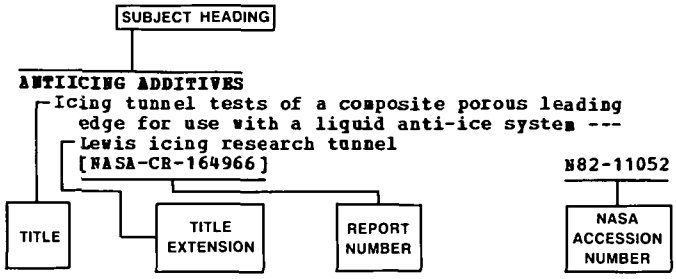

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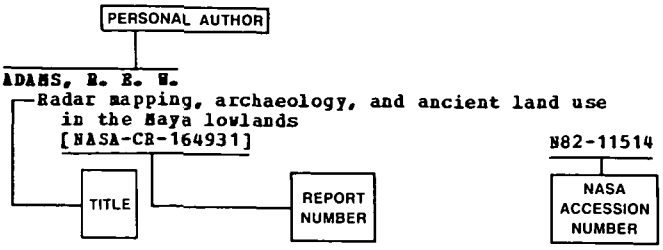

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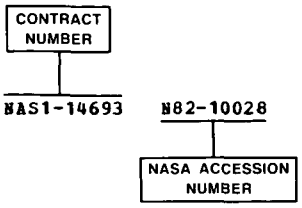

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